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CONTENTS.

	PAGE
Editorial	877
The Philadelphia Meeting of the National Academy of Sciences	880
Electrical Engineers of the Day—XXII; Cummings C. Chesney	880
Debt of Electrical Engineering to C. E. L. Brown—III; by B. A. Behrend	881
Air-Gap Induction, by F. W. Carter	884
Changes in Arc Lighting, by Alton D. Adams	888
Power Transmission on the Susquehanna, by O. P. Waters	890
"Distribution." Discussion by the American Institute of Electrical Engineers	890
Reciprocity Resolution Adopted at Washington	892
The Morton Current	893
Supervision of Electrical Circuits in Cities	894
Marconi Stations for Newfoundland	894
An Anglo-American Building for England	894
Electric Furnace with Magnetic Field	895
New Telephone Patents	895
The Edison Storage Battery	896
The Institute Meeting and New Members	896
Current News and Notes	897
LETTERS TO THE EDITORS:	
Modified Three-Wire System, by L. J. B. Wall	898
Electrical Engineering in England, by A. C Shaw	898
Digest of Current Electrical Literature	899
New Books	903
Motor-Driven Tools	903
Bullock Railway Generators	905
The Regulation of Electric Light	906
Reliance Dynamo and Motor	907
Coal Handling Machinery for a Small Plant	907
DEPARTMENTS:	
Financial Intelligence	908
Commercial Intelligence	909
General News	911
Trade Notes	915
Illustrated Record of Electrical Patents	915

SUBMARINE BOATS.

The performance of the "Fulton" in staying under water for 15 hours at Peconic Bay, L. I., is a notable feat, and, we presume, constitutes a "record." It has naturally attracted considerable attention, but will soon be surpassed, if not here then in Europe. Mr. Loubet, who has done so much in submarine boats in France, has just been awarded a prize in recognition of his work, and he and his fellow countrymen are hardly likely to leave Mr. Holland in undisturbed peace. It will be interesting to get the official report of the two Navy officers on board, and learn their views, for the Navy has been very conservative as to this submarine boat development, and the same is true of the English Navy. Such a test as this, while praiseworthy, leaves much to be proved. That clams will not sing has never been urged very warmly as an argument in their favor, and a submarine boat that simply lay motionless in its oozy bed would be of little use to anybody. The next tests, therefore, of any validity must be those bearing on the utility of such craft in battle, or at least in the supreme qualities of activity, agility, dirigibility and offense. But even as they are, these craft would cause the admiral of a foreign fleet off Sandy Hook some little anxiety and worry, for in actual warfare, brave Merrimac crews would be plentifully forthcoming, ready for any dash or forlorn hope. The rest of the demonstration, that of the "offensive" kind, is now in order.

THE INSTITUTE MEETING.

President Steinmetz, who is no *roi faineant*, is to be heartily congratulated upon the success attending his work in co-operation with that of the Institute papers' committee to secure better meetings. Indeed it is rather curious that one who has become associated in the mind of the average member of the Institute with very dry and abstruse mathematical papers, tending to somnolence and empty seats, should now be foremost in presenting matter-of-fact, everyday, bread-and-butter programmes. Just what subject Mr. Steinmetz proposes to leave for his successor after these grand round-ups is not quite clear, but probably if the future presidents only go over the same hackneyed ground again, they will still be able to muster excellent papers and large audiences. The great problems are ever with us, in engineering as in religion, and the Institute management does wisely and well to recognize this very patent fact. Even if it be regarded as somewhat of a concession to the mere wants of daily human nature, to leave more material for the *Journal of Mathematics*, there is consolation in the thought of the French philosopher that after all to satisfy the multitude, a high level of mediocrity must be achieved.

The papers presented last Friday night, as our abstract shows, were in reality an unusually strong batch, and form a welcome addition to current data and discussion. They provoked quite naturally a brisk and interesting discussion, to which and the papers we hope to pay specific attention. It was no harm that the perennial controversy between "direct" and "alternating" should pop up. It would be hard to keep away from the theme, with so many men still around who would find it even in a proposal to put the Gospels into modern Greek. But so long as these discussions help to elucidate a topic and add in ever so slight a degree to the sum of human knowledge, they do good, while at the very worst a symposium presided over by Steinmetz becomes at once an enjoyable and memorable function.

BALLOON TELEGRAPHY.

The utilization of balloons in connection with wireless telegraphy is not altogether a new idea, and there is extant an interesting report by Dr. Slaby of his work in that branch of the art in Germany. Mr. Tesla, with his wonted daring, has proposed and patented schemes not only for conveying intelligence but for transmitting power by the same aerostatic agencies. We now note in our columns the plans of Mr. Marconi for some wireless telegraphic balloon work on the dangerous coast of Newfoundland. The efforts and the success of this inventor have already proved so valuable we should be sorry to see him run any unnecessary risk in the higher altitudes of the air. Probably the balloons will not go up on windy days—like those of the present week; but even then there are the fogs to be reckoned with, although here again Mr. Marconi will be disappointed if he does not get typical Newfoundland weather. From what we know, London is the ideal area for fog experimentation, and being well inland a balloonist who goes up from Highgate Hill may count upon landing on a Surrey common or in the Lincolnshire marshes, instead of in the open sea. But to go ballooning around St. Johns is a little like going over Niagara in a barrel, and we can only hope that Mr. Marconi and his associates may be able to combine success with safety. Doubless there is more in their plans than is given out, for while the answering steamer is not expected to get an offing of more than two or three hundred miles, why should she not, with favoring circumstances, keep on until she finds herself in Vigo Bay, or in the lower reaches of the Tagus at Lisbon, still whispering cohererently with the far Atlantic shore? That is a consummation devoutly to be striven for, and no longer needs an effort of the imagination.

THE EVOLUTION OF STREET-LIGHTING.

The statistical examination of arc lighting in Massachusetts to be found elsewhere in our columns, gives a very clear impression of the changes that have taken place in the art of street lighting since the first introduction of electricity into this particular service. Beyond doubt there have been few changes more sudden and complete than those due to the introduction of the series enclosed arc lamp. The passage from open to enclosed arcs was not, however, quite as violent as Mr. Adams' figures on their face would show. From 1895 on enclosed arcs were making rapid and steady headway on commercial circuits worked at constant potential; in fact, it would not be putting the case too strongly to say that the growth of constant-potential arc lighting in this country has been largely due to the successful introduction of enclosed arc lamps. The first enclosed lamps were of the constant potential form and the series lamps were rather slow in coming to the front because of the high voltage required per lamp. By the middle of 1897, however, series enclosed lamps were successfully introduced on commercial circuits in Boston, and once the first step was taken further progress was very rapid, so that at the present time more than half the arc lights in Massachusetts are enclosed; and it is safe to assert that the other half are retained solely by reason of the cost of changing. But the figures under discussion tell only half the story of changes in the art, for in passing from open to enclosed arcs, it is of late very common practice to install the latter for operation in series from alternating circuits.

Another stage of evolution in street lighting is the decrease in the use of series incandescent lamps, either on arc circuits or on series alternating circuits, especially for street lighting. The incandescent lamp for arc circuits has been for years the pet abomination of the station manager. It has very often been demanded by lighting committees stricken with a fever of petty economy, and has sometimes been used on a considerable scale. But the lamps possible to use on an ordinary constant-current circuits are almost always of low economy and poor life, especially if reckoned in candle-hours. As a matter of experience, lamp renewals are generally so considerable as to make such lights costlier to maintain than arcs of corresponding power, unless the lamps are allowed to burn until they break. The special alternating incandescent circuits are a little better in this respect, but broadly the objection to street lighting by incandescent lamps is that they are generally allowed to burn until they are little better than red-hot hairpins. The same divining process is the reason why, as a rule, Welsbach street lights prove highly unsatisfactory. If an inspector with a long club were authorized to patrol the circuits and smash every bulb or mantle that had grown dim, it might be possible to obtain from incandescent lights the results indicated by the beautiful curves which have played a conspicuous part in some recent papers on street lighting; in fact, a street lighted by incandescent lamps, electric or gas, is nearly always a poorly lighted street, far less effectively lighted than if the same appropriation were expended on arc lights. In theory the arc is too powerful for economical use in the illumination of streets if minimum or even average illumination is to be the criterion of good lighting, but in practice the incandescent lamp is not powerful enough, for its initial brilliance is one thing and its average or final brilliance quite another. When a street is filled with trees so that lights must be near together and hung rather low to avoid shadows, incandescents can and do give excellent results, but if kept rigidly up to the standard power the renewals become a serious matter.

Within a short time there has been considerable interest in arc lamps of low power as substitutes for incandescents. Such arcs hold their brilliancy well with ordinary care in keeping the globes clean, but they have troubles of their own. No arc lamp in commercial use has quite equaled the old 2000-cp open arc when burned with high-grade carbons and kept in perfect order. Its light was white and powerful, and the resulting illumination was highly satisfactory. But these lamps were seldom kept in perfect order, and carbons of the grade employed in enclosed arcs, or in open arcs abroad, have rarely been in use in them so that practically the modern series enclosed arc operated with 6.5 to 7 amperes of continuous current gives an all-around result better than our old friend of the 2000 alleged candle power. The enclosed arc is somewhat bluish in color, but it gives a steady, clear and well distributed light. The alternating-current enclosed arc when pushed to about 7.5 amperes gives an equivalently good result. But when it comes to small units the enclosed arc as generally installed is at a disadvantage. Whether for alternating or continuous current, its light is blue as a signal torch when the amperes fall to five or thereabouts, so that in street lighting the 5-ampere enclosed arc is by no means the equivalent of the old 1200-cp open arc. Of late some interesting experiments have been tried with carbons of small diameter giving an increased current density in the arc. These have been, we believe, fairly successful, but be this as it may, the fact is that if arcs of moderate power are to be adapted to street lighting for which they possess conspicuous advantages something must be done to obviate the blue or violet color due to the long, thin arc of the enclosed lamp. Possibly the Nernst lamp may serve a useful purpose as a substitute, but the Nernst lamp has both a globe to be cleaned and a glower to deteriorate, to say nothing of the trouble of adapting it to series circuits, so that the small arc had better come in for a thorough overhauling. At present it is far from being in a satisfactory state for street lighting. The limitation most likely to be incurred is that of voltage in case of arcs used in the series connection, and it would not surprise us to see in the future much more street lighting from constant-potential circuits than has been the custom in the past.

LONG-DISTANCE TRANSMISSION.

According to recent advices from California the power of falling water is now being electrically transmitted a distance of over 200 miles from Colgate on the Yuba River, through Oakland to Redwood City, and thence by secondary distribution to Burlingame, 20 miles south of San Francisco. It is stated that in January next this power will be carried into San Francisco, making a total distance of transmission of 222 miles. This is just about double the distance of the celebrated Lauffen-Frankfort transmission of 1891 (110 miles) in which the pressure was usually about 8 kilovolts, raised occasionally to 14 kilovolts, and in which the power transmission was a little over 100 kilowatts. In 10 years, therefore, the pressure has been greatly raised, and the actual distance of transmission has been practically doubled. The reason why California is the center of these long-distance transmission plants is mainly owing to the high price of fuel in that region, and partly owing to the fine climate and the facility which exists for employing high electric pressures. It would seem as if 60 kilovolts may become a standard commercial pressure in California.

We have already presented our readers with very full accounts of the interesting work of the Bay Counties Power Company, upon which this notable transmission is based. The articles were written by a staff editor, who has been over much of the ground, and we need only refer our readers to his reports and to that by Mr. Sterling on the line itself, for a very complete idea of the difficulties and the manner in which they were met. It would be hasty to infer from the work in California that it will soon be repeated elsewhere under as favorable conditions; but the example will be hard to resist. Indeed, similar plans are now being realized in India and are discussed for other regions where fuel is scarce and water power is abundant. Meantime, Niagara transmission halts at twenty miles.

AIR-GAP INDUCTION.

Mr. F. W. Carter's communication in this number is an important contribution to the intricate subject of the distribution of magnetic flux over the surface of a tooth-cored armature. Dynamo designers usually employ empirical rules for dealing with the effect of the slots in an armature upon the magnetic reluctance of the air-gap. The accurate determination of the magnetic flux distribution over a dynamo armature is a hopelessly complex problem, which even if completely analyzed and resolved for any theoretically assignable case, would probably be much too laborious to compute in the practical design of dynamos. At the same time, every step in the process of analysis is an advance in the direction of electromagnetics, and is a valuable addition to the stock of technical knowlege. The solution presented by Mr. Carter does not purport to be a complete solution of the practical problem, but is a solution of an ideal case approximating to that of the practical problem.

The ideal case worked out is the flux distribution accompanying the presentation of a rectangular pole, whose entire surface is at one magnetic potential, to a flat parallel armature surface, all of which is also at another magnetic potential, which may conveniently be called zero. In other words, the solution presented does not take into account the difference of potential by magnetic "drop" in the iron of the field or armature, and, moreover, does not take into account the gradual rise of magnetic potential from the yoke end to the armature end of each pole-piece. Neither does it consider the influence of the conformal bending of pole face and armature, rendered necessary by the cylindrical shape of the armature. Nevertheless, these reservations have in ordinary practice much less influence upon the magnetic distribution, than the presence of the teeth and of the polar edges, so that within reasonable limitations the results reached and tabulated in Mr. Carter's curve sheets cannot fail to be of service as a basis for the correcting of the empirical formulæ of the designers and engineers. Thus, Fig. 6 representing the equivalent increase of air-gap length for different dimensions of teeth shows, for example, that when the teeth and slots have equal breadth, the air-gap is virtually increased 50 per cent in length, or in reluctance, when the slots have a width of 10 times the actual air-gap. Assuming that the computation is correct, this shows the superiority, in point of air-gap reluctance, of tunnel armatures over slotted armatures.

The method which is used by Mr. Carter for the solution is based on the now well-known rectangular transformation operator in connection with conjugate functions, and forms a powerful weapon of analysis. A few cases of the application of this operation are worked out in J. J. Thomson's "Recent Researches in Electricity." With the aid of this theorem, the direct solution is obtained of a problem which has been attacked by Professor Goldsborough in a different but simpler and indirect manner. In the device represented at Fig. 8 Mr. Carter introduces a very beautiful principle, which we do not remember to have seen previously suggested for any practical purpose; but which, whether new or not, promises to be of considerable value in dealing experimentally with this difficult class of problems in magnetic flux distribution. The principle depends upon the fact that when any system of equipotential lines and flow lines have been correctly mapped out in two-dimensional space, we may set up a working model of the system in a sheet by laying off thereon the system of curves and impressing a suitable electrical difference of potential between any pair of flux lines. In the limited space within the plate, the system of potentials and flux will be the same as in the wider area of the complete diagram. Also, because flux paths and equipotential lines are everywhere mutually perpendicular, we may conversely apply the impressed difference of potential along any suitable pair of flux lines in the plate, and the *equipotential* lines in the plate will then correspond to the *flux* lines of the original diagram. Moreover, in the latter case the difference of electric potential between any two points in the plate will measure the total flux passing between the same points in the original system. Mr. Carter proposes to cut out a model of the pole-piece and opposing armature surface from a uniform metal plate, and to apply a constant difference of potential to two boundaries corresponding as nearly as may be to flux paths in the actual system; the difference of electric potential measured along the surface of the armature in the plate model will then be a measure of the total magnetic flux entering the armature in the real machine.

This very interesting inverted electric model of the magnetic distribution enables the actual flux lines and equivalent surfaces to be mapped out for all shapes of pole-pieces and slotted armatures, no matter how complex, but subject, however, to the assumptions that there is no magnetic drop in the iron, and that the entire surface of the pole has one and the same magnetic potential. This will entail some deviation between the inverted electric model and the magnetic distribution in the corresponding actual machine. Moreover, the electric model is in two dimensions, whereas certain disturbance of the purely cylindrical distribution occurs in the actual machine of three dimensions at the ends of the armature cylinder. In spite of these disturbing influences, the plan suggested is a promising one, and would form an excellent practical research for the thesis of a graduating student. A number of inverted electric models, cut out of German silver sheet, could be prepared for slotted armatures covered by poles of different angular spread. The flux distribution and equivalent air-gap or polar fringe could be studied in these models with the aid of a storage cell and a potentiometer, with great detail.

The Philadelphia Meeting of National Academy of Sciences.

The fall meeting of the National Academy of Sciences was held at Houston Hall, University of Pennsylvania, Nov. 12-14, President Ira Remson, of Johns Hopkins University presiding in the absence of both president and vice-president.

Twenty-three papers were read, including several of much interest, notably that of Professor George F. Barker on the monatomic elements, illustrated by a complete set of these elements, argon, helium, neon, krypton and xenon, in glass tubes from the laboratories of Dewar and Ramsay, being the only collection of the kind in America. They give very brilliant colors when the electrical current is passed through them. Argon gives two distinct colors, one with direct, another with alternating current.

There was, however, a dearth of papers on electrical subjects. Professor Barker lectured on the newer forms of incandescent electric lamps, including the Nernst lamp, in a popular and interesting way. Dr. Barker also explained the osmium filament now controlled by the Welsbach people, which he says give even better results than the Nernst lamp, being far less expensive.

The programme included only two other electrical papers, both by Dr. Carl Barus, and read by title only, as they relate to preliminary investigations which Professor Barus is not willing to publish yet. They were (1) "On Quadrant Electrometry with a Free Light Needle Highly Charged Through a Conductor of Ionized Air," and (2) "On Nuclear Condensation in the Vapor of Non-Electrolytes like Benzene, and On Graded Condensation."

Among other papers read were the following: "Observations on Tungsten," by Edgar F. Smith; "A New Gauge for the Direct Measurement of Small Pressures," and "Transmission of Heat Through Vapor of Water at Small Pressures," both by Edward W. Morley and Charles F. Brush. Professor Cyrus B. Comstock presented a biographical memoir of the late General John Newton, and the work of the International Association of Academies was sketched by Professor Henry L. Bowditch.

Electrical Engineers of the Day—XXII.

Cummings C. Chesney.

Cummings C. Chesney, who is a Pennsylvanian by birth, entered the Pennsylvania State College in 1881, and was graduated therefrom as a chemist four years later. For some years after leaving college Mr. Chesney was greatly handicaped by an injured foot that made it impossible for him to follow any pursuit necessitating great physical activity, and in consequence he spent three years in teaching mathematics and chemistry at the Doylestown Seminary and Pennsylvania State College.

In 1888 he joined Mr. William Stanley's laboratory force in Great Barrington, Mass., where he devoted himself particularly to experimental chemistry and to electro-dynamics. The following year he went with the United States Electric Lighting Company, in Newark, where he designed and developed for this company its small direct-current motor and generator work, at the same time following various lines of investigation in applied electricity. In the fall of 1890 he removed to Pittsfield, Mass., where he was one of he original incorporators of the Stanley Electric Manufacturing Company. He was also one of the members of the Stanley Laboratory Company.

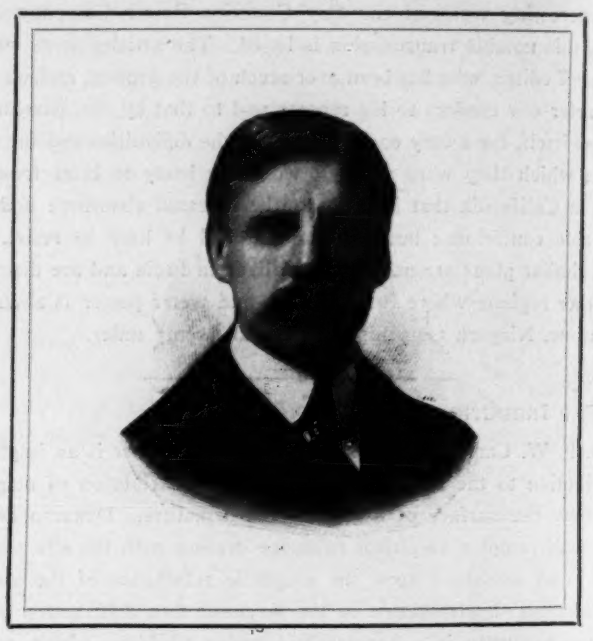
After the incorporation of the Stanley Electric Manufacturing Company, it soon became apparent to those associated with Mr. Chesney that his broad general knowledge and clear conservative judgment indicated him as the man to guide the electrical departments of the manufacturing establishment, and the future demonstrated that this estimation was not at fault.

With his associates and staff of assistants, Mr. Chesney early perfected the inductor type of alternator to a point far beyond anything before reached in this country and not surpassed in the world. To him is due the credit of having laid out the first polyphase power transmission plant to be put into successful operation in America. This plant is at the present day supplying light and power for use in the towns of Housatonic and Great Barrington, Mass.

When Mr. Chesney and those around him contended that alternating-current generators could be run in parallel under conditions prevailing in practical operation, they were opposed by almost all American engineers of standing, yet the fight proved a winning one. When others were ready to prove that the winding of 10,000 to 12,000-volt generators was an impracticability, Mr. Chesney designed alternating-current generators for such voltages with great success. It might be added that for even lower voltages Mr. Chesney was the pioneer, as the first 6000-volt generators built and successfully operated in America are of his design and are still furnishing alternating-current power to Quebec.

When it became apparent that transformers of large capacities would be a valuable addition to the electrical plants of the time, notwithstanding predictions to the contrary by those presumably in a position to know, he with his associates again realized their convictions in a most satisfactory manner, and to him is due the design of the first commercial 100-light transformer ever used in this country, which was made by the Stanley Electric Manufacturing Company in 1891.

A long list might be given of electrical developments in which Mr. Chesney has been a pioneer. Among other work, switchboard instruments, high-tension arc-breaking devices, frequency indicators, indicating wattmeters, lightning protection for high and low-tension circuits and many other appliances, have all had a share of attention and always with satisfactory results. One of the most striking and practical exhibits at the Pan-American Exposition was the "S. K. C." phase and frequency-changer, which transformed the three-phase 25-cycle Niagara currents to two-phase, 50-cycle currents for



lighting and power purposes in the Electricity Building. This is one of Mr. Chesney's more recent inventions.

Mr. Chesney is seldom idle, and an idea of value his little chance of escaping him, as is shown in some degree by the numerous patents issued to him, and by the many unique and valuable details to be found in the "S. K. C." apparatus. His friends like to think of him not only as the man of resource and energy, always ready to seize the best that can be found and incorporate it into his work, but they also remember his enthusiasm for athletic sports and the time when he was one of the most clear-minded college baseball catchers and coaches in the country. His control over his fellow students was remarkable at all times, and he had an intuitive knowledge of their strong points. When it was a question of organizing a champion baseball team, he saw quickly how to use the available material at hand. This characteristic of prompt thought and the ability to make the most of men and things about him has remained with him through all of his engineering and research work, and has been one of the potent factors in placing that work in the rank of highest order. He has, in short, always been a man of action rather than of words, but when the latter prove necessary they are forcible and cogent.

In addition to being chief engineer of the Stanley Electric Manufacturing Company, Mr. Chesney holds the position of consulting engineer for the Northern Electrical Manufacturing Company, of Madison, Wis. He is a member of the American Institute of Electrical Engineers and a director in a number of electric lighting and power companies throughout the country.

The Debt of Electrical Engineering to C. E. L. Brown.—III.

BY B. A. BEHREND.

ALTERNATING-CURRENT MACHINERY.

WE have described briefly in the preceding articles the designs and work of Mr. Brown in the development of the direct-current dynamo in its adaptation to the transmission of power and to electrolytic purposes. But while we consider this work which was done in the latter half of the eighties of great interest and importance, we must admit that it is in large measure eclipsed by Mr. Brown's work in alternating-current machinery. Here his ability and genius, his enterprise and boldness, found a wide and congenial sphere of activity. In 1889, still connected with the Oerlikon Company, Mr. Brown took up the design of transformers and of alternators for single-phase currents. One of the first machines built by him is illustrated in Fig. 11. The alternator is of the Kapp type, for about 80 kilowatts at 2000 volts. An entirely novel and original feature is the direct-connected exciter, a construction which Mr. Brown has consistently adhered to for the past 12 years. With these machines Mr. Brown operated in Kassel, Germany, one of the

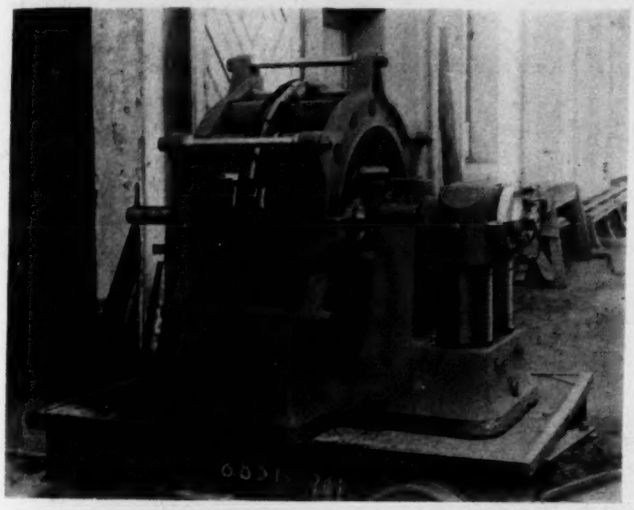


FIG. 11.—ONE OF BROWN'S SINGLE-PHASE ALTERNATORS OF THE KAPP TYPE, WITH DIRECT-CONNECTED EXCITER, 1889.

first single-phase power transmission plants worthy of the name. There are two 100-hp generators operating in parallel, producing current at 2000 volts and transmitting it over five miles through a Siemens concentric cable. The two motors are driving direct-current generators which are operating in parallel with a storage battery, from which current is taken to start the motors and to synchronize them. The plant has operated for years proving the excellence of the workmanship and mechanical design of the machines, features which always marked machines manufactured at Oerlikon. The satisfactory parallel operation of these machines without "hunting" is worthy of notice.

The Kapp type of single-phase alternator was also adopted by Mr. Brown for the Zurich station, where four 300-hp generators at 50 cycles and 2000 volts were installed in 1890, and have been running since. They are all connected to the same shaft by clutches clearly visible in Fig. 12. The station has been greatly enlarged, and these generators, which are driven by turbines, are now operating in parallel with steam-driven inductor generators of the Oerlikon Company.

THE ADVENT OF POLYPHASE CURRENTS.

Before the introduction of polyphase currents for driving motors, the direct current had hardly any rival. Attempts had been made to make a motor for single-phase alternating currents, and Professor Elihu Thomson had taken out some patents in 1887 on some self-starting single-phase motors embodying the principle of induction, i. e., the armature and field were not *connected* with each other as in direct-current motors, but the rotary effect was produced by currents *induced* by the field in the short-circuited coils of the revolving armature. The basis of the induction motor, though for single-phase circuits, was thus laid for the first time. That this motor was not for a long time properly dimensioned and designed was the reason that it had almost sunk into oblivion. We may here remark that we owe to Mr. Brown's skill the first successful single-phase motors embodying Thomson's principle of induction.

In 1888, through the labors of Tesla and Ferraris, the principle of induction became most fertile through their applying it in connection with two independent single-phase currents of different phase. But the Tesla motor was not an economical machine, and the labor was not small that had to be expended on it to make the modern induction motor. To throw some light on that phase in the history of the application of electricity to industrial ends, we wish to cite Professor Elihu Thomson who wrote in 1900:

"These long-distance power transmission plants are generally spoken of as 'two-phase,' 'three-phase,' or 'polyphase' systems. Before 1890 no such plants existed. A large number of such installations are now working over distances of a few miles up to 100 miles. They differ from what are known as single-phase alternating systems in employing, instead of a single alternating current, two, three or more, which are sent over separate lines, and in which the electric impulses are not simultaneous, but follow each other in regular succession, overlapping each other's dead points, so to speak.

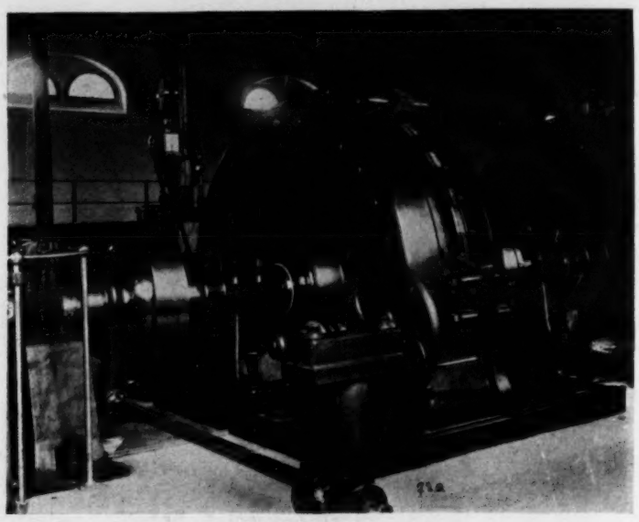


FIG. 12.—BROWN'S KAPP ALTERNATORS AT THE ZURICH CENTRAL STATION.

Early suggestions of such a plan, about 1880, and thereafter, by Bailey, Deprez and others, bore no fruit, and not until Tesla's announcement of his polyphase system in 1888, was much attention given to the subject. A widespread interest in Tesla's work was invoked, but several years elapsed before engineering difficulties were overcome. This work was done mainly by the technical staffs of the large manufacturing companies, and it was necessary to be done before any notable power transmission on the polyphase system could be established. After 1892 the growth became very rapid."

This is Professor Elihu Thomson's presentation of the development of the polyphase system, and a more accurate and correct version could hardly be given. Generators for polyphase currents were not new in 1888, the principle of induction had been explained and demonstrated a year before by Thomson, but Tesla's combination of them was a great step in advance. The somewhat erratic nature of Mr. Tesla and the popular applause that he has received—entirely uncoveted as it may be—have of late done a good deal to discredit the man and his work. But while the younger generation, presumptuous in their criticism, ignore a man's good work, it is unbecoming to thoughtful people to follow their example. Mr. Tesla's paper was read in May, 1888, before the American Institute of Electrical Engineers, and it had excited a good deal of comment. But singular though it may be, the changes, which we are now tempted to call slight, but without which the system was not workable, were slow to come.

Strange to say, the working ground seemed to have gone from America, where it had taken its start, to Europe. Adverse circumstances seem to have prevented the Westinghouse Company who had

acquired the Tesla patents in 1888, from developing the system for which they have done so much in later years. Mr. Lewis B. Stillwell, then connected with the Westinghouse Company, says that "Mr. Tesla came to Pittsburg in the summer of 1888. He brought with him a number of his motors, an induction regulator, and other devices pertaining to the system. The work of developing a variety of sizes of the motor to meet the commercial demand which had begun to make itself felt almost as soon as the Westinghouse Company began the introduction of alternating-current apparatus, was prosecuted in the shops of the company under the direction of Mr. Tesla, and during the next two years a number of generators and motors were sold and put into commercial service. Among these plants was one sold to the Hercules Mining Machine Company, of Pittsburg, which consisted of a 60-hp, two-phase generator, and the number of motors of the sizes required by the Hercules Company for the operation of their machines. The majority of these motors were of the 3 horse-power size. During the latter part of 1889 and in 1890 and 1891 the commercial introduction of the system was seriously hindered by financial difficulties in which the company had become involved. In 1892 the company began to vigorously push the commercial introduction of the system upon a very large scale, and in October, 1893, the Cataract Construction Company awarded to the Westinghouse Company the contract for a 15,000-hp generating plant."

The conditions here referred to by Mr. Stillwell in connection with the tremendous development of electric traction work that directed the torrent of activity in this country from the alternating current, account in large measure for the shifting of the working ground in the latter field above referred to. America can well afford, in the consciousness of her great work in the field of electric traction, and of her great work in power transmission of more recent date, to give credit to some of Europe's best engineers for the development of much that made the polyphase system what it is to-day. After these introductory remarks we will return to our subject.

The two-phase system of Tesla was simplified and improved by Michael von Dolivo-Dobrovolsky through the introduction of the interlinked three-phase system which has almost entirely supplanted the two-phase system for power transmission. When Mr. Brown in 1890 entered the field of polyphase currents, he found a perfect sea of ideas, and an almost infinite number of mostly useless patents referring to motors, generators, transformers and transmission lines. But with the keen insight of genius he sifted the wheat from the chaff and set to work to design a suitable generator for three-phase currents, to make the induction motor an economical machine, and to construct transformers for high-tension work. In regard to the use of high tensions Mr. Brown writes:

"When I hit upon the idea that probably a properly insulated ordinary overhead line could carry without considerable loss higher tension than had yet been dreamed of, I set about designing (middle of 1890) a transformer for producing these high tensions. As there was at this time a good deal of talk about the Brooks' oil-insulated cables, I thought it would be good to use oil also for transformers,[1] and introduced it for this case with such success that now all over the world oil is used when it is a question of making a transformer for durability or to meet the requirements of high-tension work."

Fig. 13 is a photograph of the high-tension testing set in Oerlikon, where, in 1890, Mr. Brown showed the German technical commission the possibility and feasibility of even 40,000 volts for the transmission on oil insulators over long distances. A direct current, with starting resistances, is seen on the right driving a small alternator, which is shown with its field resistance. The current was sent through a fuse, a switch and an ammeter to the step-up transformer. The secondary tension of this transformer was measured by a Kelvin electrostatic balance, and it was connected to an overhead line consisting of 100 fluid insulators outside the room, re-entering the room again to connect with the high-tension side of the step-down transformer. In an adjoining dark room Mr. Brown observed the effects of the high tension on different types of insulators. "These testing transformers were run up to over 40,000 volts," writes Mr. Brown, "without the slightest hitch, and enabled me to carry out the series of experiments which terminated in the Lauffen-Frankfort experimental plant."

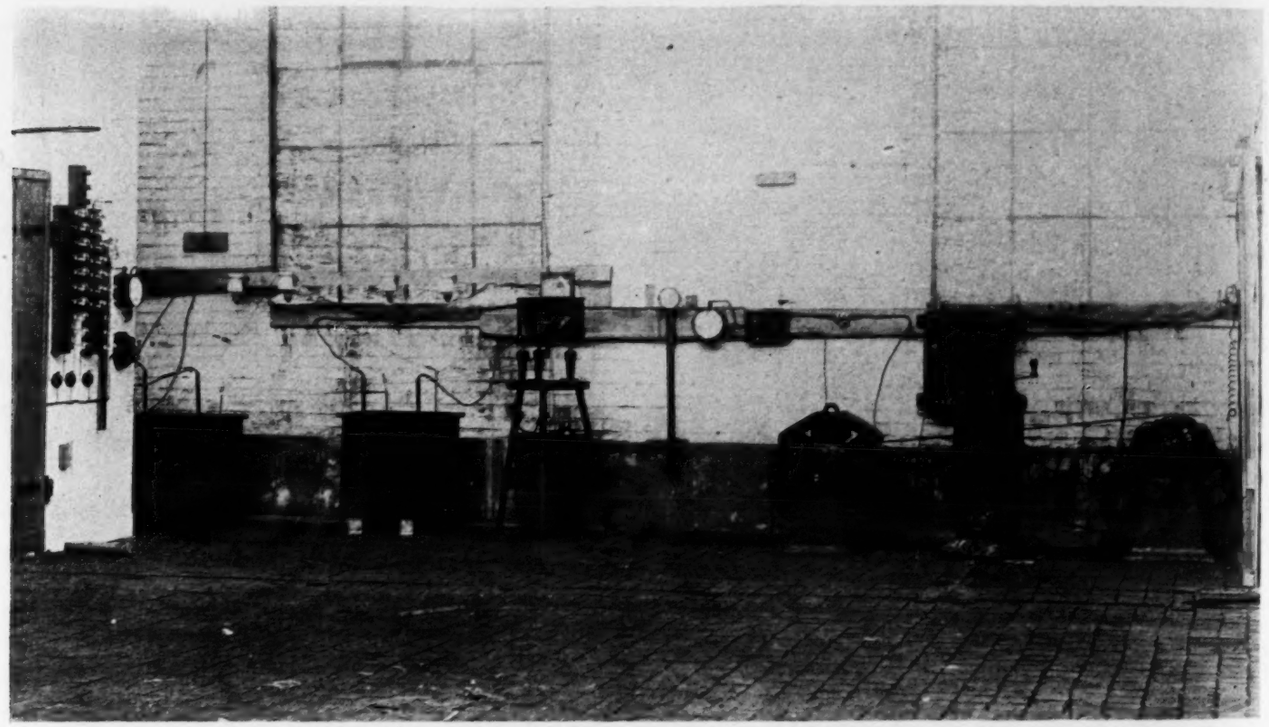


FIG. 13.—BROWN'S 40,000-VOLT HIGH-POTENTIAL TESTING SET IN OERLIKON, 1890.

In regard to the Lauffen-Frankfort experiment we content ourselves with quoting Professor S. P. Thompson:

"Great skepticism prevailed at first as to the probable result of transmission under the novel conditions of using such very high voltages over so long a line, and with polyphase currents. It was anticipated by some that the efficiency would be greatly reduced by possible disturbances due to the capacity of the lines acting as condensers or to leakage over the 10,000 insulators on which the line was supported. In private, some who were very closely connected

[1] "The first application of oil for insulating purposes was made by Brooks for his underground conductors, by putting ordinary insulated wires into tubes which were filled with oil." Lecture of C. E. L. Brown, "On High Pressure, Its Generation, Transmission and Application," Frankfort, February, 1891.

with the enterprise expressed their fears that the efficiency should fall below 50 per cent, and at one time there was some apprehension that the jury would not be allowed to make full tests. However, as experience was gained these fears were found to be empty. The elaborate tests carried out by the commission in the autumn months, mostly at about 8000 volts pressure, showed that the energy given out electrically at Frankfort was as much (on the average) as 74 per cent of the energy given by the turbines at Lauffen to the generator.

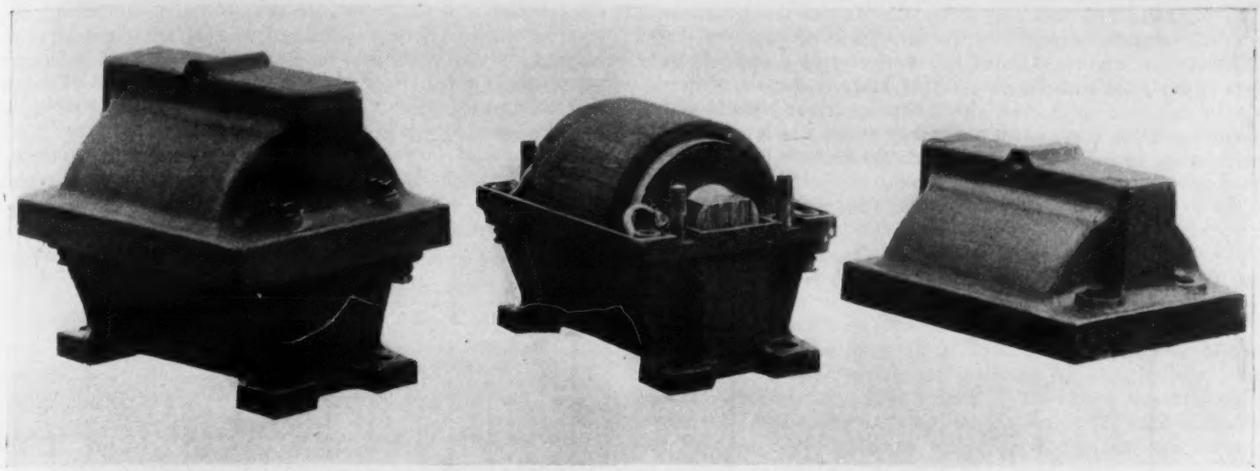
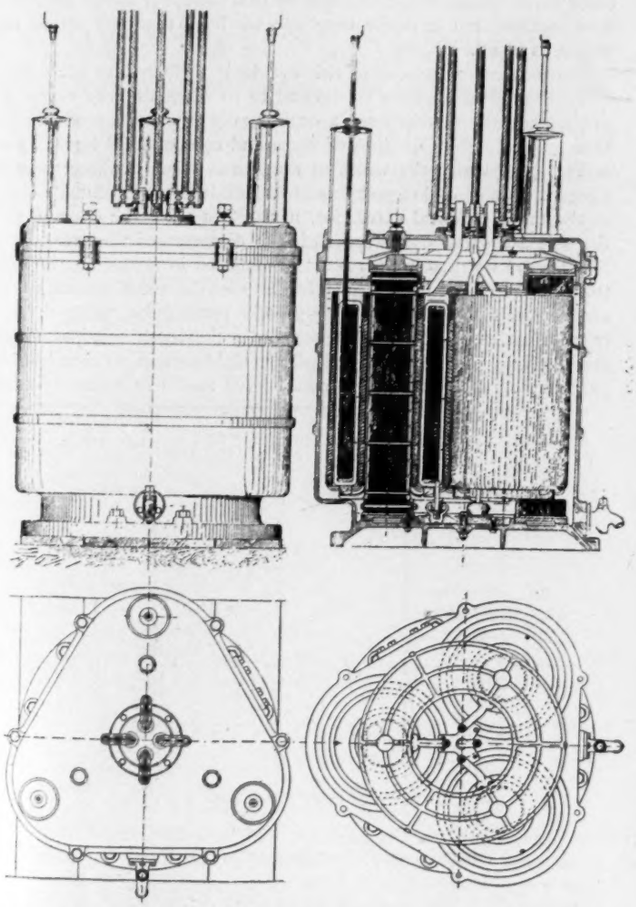


FIG. 14.—BROWN SINGLE-PHASE TRANSFORMERS, 1889.



FIGS. 15 AND 16.—200-KW HIGH-POTENTIAL THREE-PHASE LAUFFEN TRANSFORMER.

"The Lauffen-Frankfort transmission was much more than a mere experiment. It was a daring and successful demonstration not only of the utility of high voltages in the transmission of power, but of the success of polyphase currents. As such it marked an epoch in the commercial development of electricity. It evoked an extraordinary interest throughout the continent of Europe and in Germany in particular."

It will be of interest to give some good illustrations of some transformers of Mr. Brown's designed about twelve years ago. The transformer represented in Fig. 14 is a small core transformer, the coils being cylindrical and easily removable. The core has no bolts or rivets, the plates being forced into the cast iron frame, a very ingenious construction. Fig. 16 represents the 200-kw, three-phase transformer for the Lauffen-Frankfort experiment. It was designed for 15,000 volts at 50 cycles, and shows the ring-shaped yoke designed by Mr. Brown for the purpose of making three-phase transformers. Fig. 15 shows the transformer in its cast iron case.

In 1898 Mr. Brown adopted another way of connecting the three cores of a three-phase transformer. Fig. 17 shows this transformer. Other constructions of transformers will be described later on.

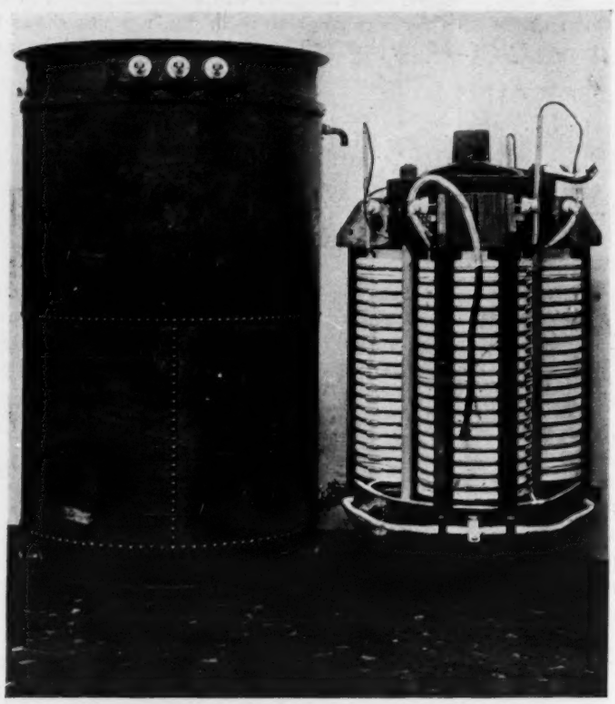


FIG. 17.—HEILBRONN TYPE OF THREE-PHASE TRANSFORMER.

Air-Gap Induction.

BY F. W. CARTER.

SO much has been written on the theoretical determination of the magnetic field occurring in various parts of the dynamo, that the average person may be excused if he supposes that a mathematician who investigated the subject could predetermine the force at any point with accuracy. This, however, is so far from being the case that no process with which we are acquainted will so much as touch so complicated a magnetic problem as is presented by the dynamo. Some few of the formulæ which have been developed are capable of giving approximately correct information concerning the field in limited regions, and so have a correspondingly limited use, but many have neither practical nor theoretical value, and serve only to mislead the user with their pretensions to accuracy. One having some acquaintance with the subject would do better to trust his native wit than use such formulæ to guide his judgment in investigating the variations of the field. He at least will not corncern himself then about that third significant figure.

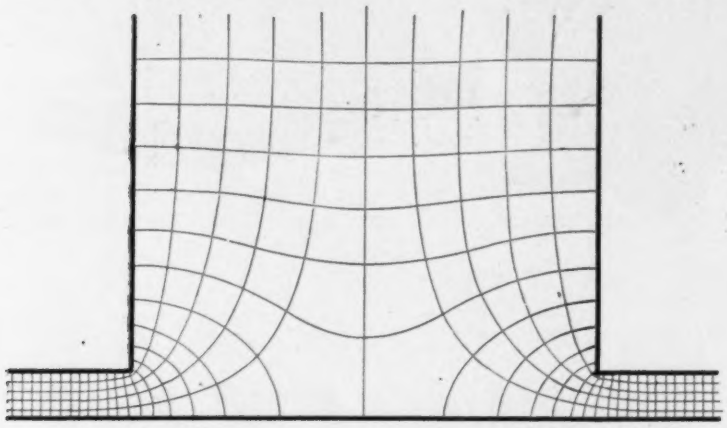


FIG. 1.—LINES OF FORCE BETWEEN TWO POLES.

In a communication made to the British Institution of Electrical Engineers[1] the writer gave a complete solution of an ideal magnetic problem, devised to resemble as nearly as practicable that of the field of force in the air-gap and interpolar space of a dynamo having a smooth core armature. The armature was supposed straight in section and the pole pieces rectangular, as in Fig. 1, which shows the system of lines of force and equipotential surfaces deduced from the solution referred to, though given here for the first time. The armature and poles are equipotential surfaces, the potential of the armature being a mean between that of the two poles. In this figure the distance between the poles (2c), is 10 times the air-gap (g). Such a diagram really gives all information about the field at every point, for not only do the lines represent the direction of the force, but their density shows its magnitude, which varies inversely as the distance between consecutive lines. This is another way of saying that the strength of the field is the number of lines of force which cross a line of unit length drawn at right angles to the direction of the force. The lines of force and equipotential lines cut one another at right angles, and divide the diagram into a system of curvilinear squares.

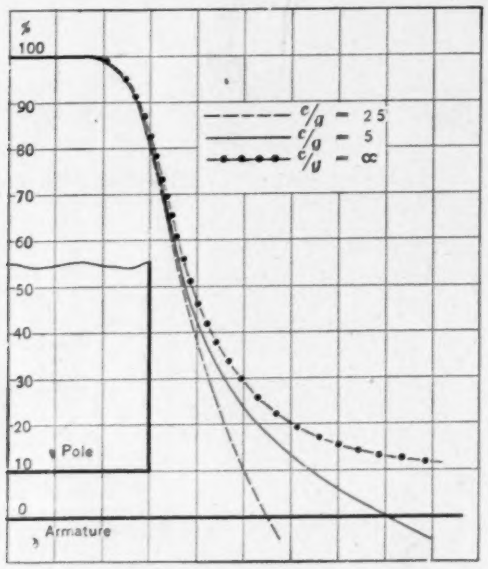


FIG. 2.—VARIATION OF FLUX DENSITY AT ARMATURE FACE.

Fig. 2 gives curves of field strength at the armature face for certain values of the ratio (2 c/g) between the distance apart of the poles and the air-gap, whilst Fig. 3 gives the fraction of the air-gap that must be added to the pole face in order to correct for the fringes at the two sides of the pole face. If this fraction be added to the width of the pole and the field under the pole face so increased be taken the same as that in the gap, the total number of lines of force will be the same as actually passes between the pole and armature.

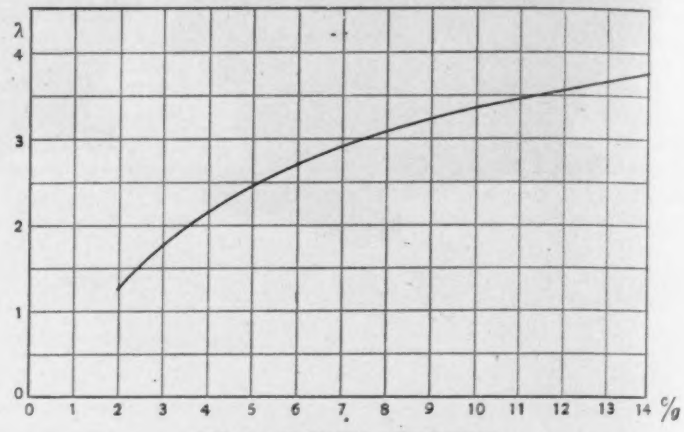


FIG. 3.—FRINGING COEFFICIENT.

The method used to deduce these results is that of conjugate functions about which something will be said later. It is not exactly an easy method, but it is the only one we have that will attack such problems at all.

The particular purpose of this article is to introduce the solution of another ideal problem so devised as to resemble very nearly that of the magnetic flux between a smooth pole face and a toothed armature. The diagram of lines of force and equipotential lines is given in Fig. 4, in which the width of the slot is taken at three times the air-gap. We should expect this ideal solution to approximate closely to the usual practical cases, for, in the first place the dimensions of the slot are small compared with the diameter of the armature, so that we are not making a violent assumption in supposing the armature to be straight instead of circular over the small portion considered. Again the slot is not unusually rectangular, as in the ideal case. Furthermore, at a distance under the tooth equal to the air-gap the lines of force are practically straight across. If they had been perfectly straight across, we could have used one as bounding the space considered in the problem, and have introduced another slot at an equal distance on the other side of this line. This would have been a true and perfect solution for a succession of slots and teeth; but as it is, we get a solution which is, in this respect, practically perfect, but not mathematically so. Fig. 4 shows that few lines of force penetrate far into the slot, so that unless this is very shallow, which is not the usual case, the depth has practically no effect. The case of a slot, square at the bottom, instead of indefinite, could be worked out,

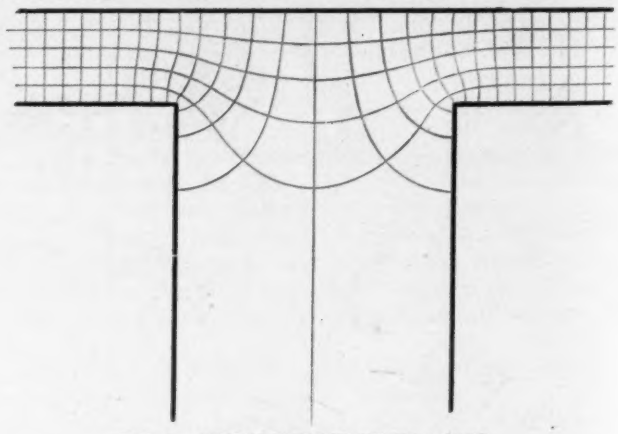


FIG. 4.—LINES OF FORCE ABOUT A SLOT.

[1] See *Journal of Proceedings* of the Institution of Electrical Engineers, 1900, Part 146, Vol. XXIX.

but, as the solution involves elliptic functions of complex quantities, it is not worth the very much greater labor of calculation, since the present solution fills the needs of practical cases.

Having determined the magnetic field about the slot, it is an easy matter to find an expression giving the effect of the slot. If we determine the total magnetic flux between two points, one at some distance to the left of the slot and the other at some distance to its right, we shall find that this flux is less than it would have been had there been no slot there, by an amount which we may conveniently express as occupying a certain length on the armature or pole face, which length we shall write as a fraction, σ, of the breadth of the slot, b. In other words, if d be the distance between the two points considered, and F_0 the magnetic force well under the tooth, the total flux

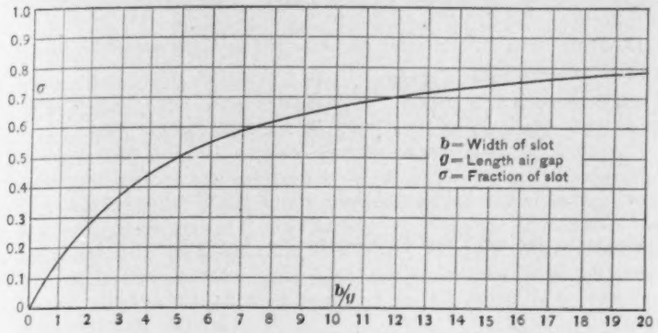


FIG. 5.—CORRECTION FOR SLOT.

beween the two points, instead of being dF_0, as it would have been had the distance d not included a slot, is $(d - \sigma b)\, F_0$, so we may represent the effect of the slot as diminishing the flux by an amount $\sigma b F_0$. Here σ is given by the equation

$$\sigma = \frac{1}{90} \tan^{-1} \frac{b}{2g} - 1.466 \frac{g}{b} \log \left(1 + \frac{1}{4} \frac{b^2}{g^2}\right)$$

where the angle is expressed in degrees and the logarithm is a common one. Fig. 5 gives σ for different values of $\frac{b}{g}$. Thus, if a be the breadth of a tooth, b being that of the slot, we may, in calculating the total flux suppose it has the same value as at the crown of the tooth over an amount of tooth-face, $a + b - \sigma b$, and is zero elsewhere. We may say, then, in finding the reluctance of the gap, that

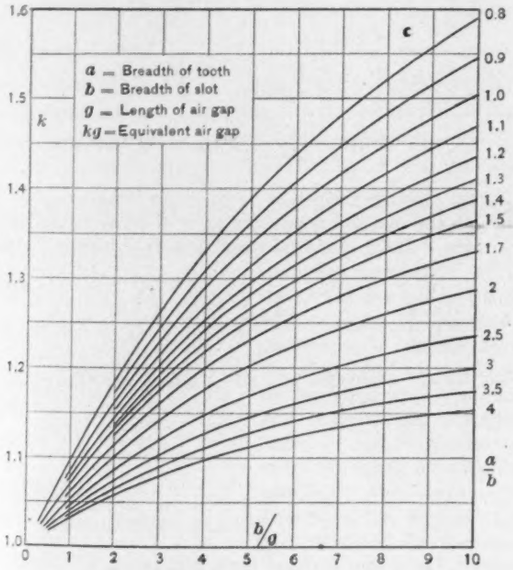


FIG. 6.—EQUIVALENT AIR-GAP.

the total flux is equal to what it would be if the induction had throughout the same value as at the crown of the tooth, and the pole face were diminished in the ratio of

$$a + b - \sigma b \text{ to } a + b \text{ or } 1 - \frac{\sigma b}{a + b} \text{ to } 1$$

or, what is better, we may say that the induction has its actual mean value, but the gap is increased in the ratio of 1 to $1 - \frac{\sigma b}{a + b}$; meaning by "the gap" the shortest gap or the distance between the pole face and crown of the tooth. This puts the results in a workable form for those requiring the equivalent air-gap. The value of the coefficient k by which the shortest gap must be multiplied to get the equivalent air-gap, is plotted in Fig. 6 for some of the more usual values of the quantities involved.

We notice that Fig. 5 can be used immediately to determine the effect of an internal ventilating duct. We have merely to take b as the width of the duct instead of that of the slot, and the curve gives the fraction of the duct that must be annihilated, in order to find an equivalent gap area without ducts, having the same reluctance as the actual gap has. It is convenient and natural to consider the ducts and fringes as affecting the equivalent area of the gap; and the slots—being distributed throughout the area—as affecting the equivalent length of the gap.

Fig. 4 shows that the magnetic induction at the pole face is variable. Of course, the variation does not penetrate far into the iron, being rapidly damped out by eddy currents. We can calculate approximately the amount of energy lost due to these eddy currents in the pole face, when we know the amplitude of the variation. Fig. 7

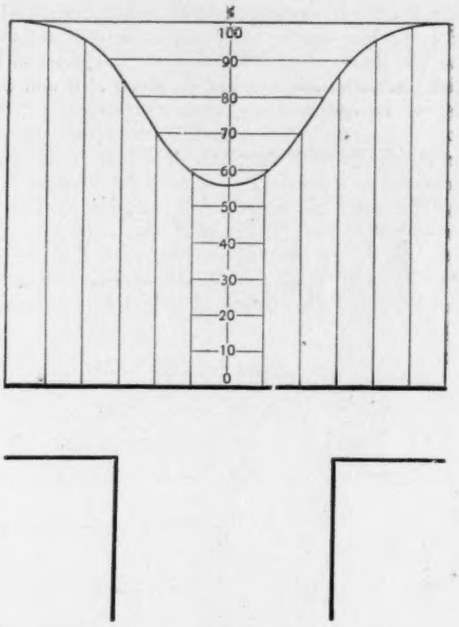


FIG. 7.—VARIATION OF FLUX DENSITY AT POLE FACE.

shows the variation corresponding to the case of Fig. 4. Here the minimum field is 0.555 of the maximum, so that the total variation is 1-0.555, or 0.445 of the maximum field. Thus the amplitude of the variation is 0.222 of the maximum field, or $0.222k$ of the mean field. In general, the amplitude of the variation is $k \left(\frac{1}{2} - \frac{1}{\sqrt{4 + b^2/g^2}}\right)$ times the mean field. Calling this amplitude B lines per square inch, the energy lost in this way is, for a solid pole face,

$$8\, B^2\, D^2\, n^{\frac{3}{2}}\, \mu^{-\frac{1}{2}}\, s^{-\frac{1}{2}}\, 10^{-13}$$

watts per square inch of pole face, where D is the diameter of the armature in inches, n the speed in r. p. m., s the number of slots in the armature, and μ the permeability of the iron of the pole face, for the induction at which it is being worked.

The problem we have to face when we attempt to obtain a genuine mathematical solution of a magnetic problem of this nature, is that of finding a potential function which shall have prescribed values at certain definite boundaries. Having found this function we can get everything. Had a definite boundary distribution of attracting matter been prescribed instead of the potential at the boundary, we could

have found the force at any point by direct integration; but as it is we cannot find the density of the layer of matter which will make the boundary take the prescribed potential until the whole problem is solved. This is the chief difference between a problem in gravitational attraction and a problem in electricity or anything of the flux kind—the law of force is the same, but nature has arranged that the boundary conditions we have to satisfy are different. Having solved a problem of the flux kind, we can generally express it in the language of another subject of the same kind. Thus, in the foregoing we have only to change magnetic force into electric force, magnetic potential into electric potential, and magnetic induction into electric displacement, to get a problem in electrostatics, to which the same solution applies. Again the solution of the problem of the slot will do for that of the flow of a perfect fluid in a straight canal past the slot shaped opening. Here the lines of flow are the magnetic equipotential lines and the equipotential lines of the fluid motion are the lines of magnetic force of the figure.

In particular the perfect fluid might be electricity flowing in uniform sheet metal of the shape of the canal. I mention this because, the problems being mathematically identical, if we can get a practical solution of one by any means, we can translate it immediately into the language of another subject.

Now, it is not difficult to trace the equipotential lines on a plate through which a current is flowing, and so we may, with sufficient precision, investigate practically problems that we could not touch mathematically. I have not had an opportunity of experimenting in this direction, but the arrangement shown in Fig. 8 should be capable of giving the required result. *A, B, C, D, E, F* is a thin, uniform plate, cut to the shape of the section of the air-gap and interpolar space. Thick electrodes are soldered on along *A-B* and *C-D*, lying, as nearly as we can guess, along what corresponds to the lines of magnetic force. Current is led in at these electrodes, and a potentiometer is put in parallel with the plate. The line on the plate having the same potential as a point (*P*) on the potentiometer, is found by connecting *P*, through a galvanometer, *G*, to a pointer which is brought into contact with the plate. If *E* and *F* represent the mid-points of the interpolar spaces, the drop of volts between *E* and *F* is proportional to the total flux between the corresponding two points on the machine, and if we find what length of strip cut from the same sheet,

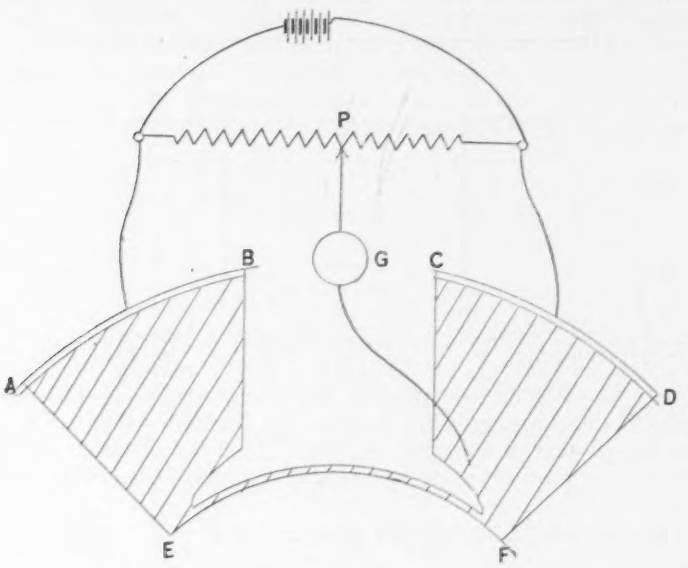


FIG. 8.—METHOD OF DETERMINING LINES OF FORCE, EXPERIMENTALLY.

and of width equal to the uniform part of the air-gap, produces the same drop with the same current, we can find an expression for the fringing immediately. In this way we could investigate the effect on the reluctance of the air-gap of chamfering the poles or other such practical point.

When we say that something is of the nature of a flux, we mean that as much of the something enters any particular space as leaves it, as much current enters a particular area on the plate of Fig. 8 as flows out of that area, or as many lines of magnetic force enter a particular volume as leave that same volume. Considering the leaving flux as entering negatively we may say that the total flux entering any space is zero. The flux is supposedly produced by a force derivable from a potential function, ϕ, so that the force parallel to the axis of x is $-\frac{\delta \phi}{\delta x}$, and that parallel to the axis of y is $-\frac{\delta \phi}{\delta y}$.

In Fig. 9 suppose the area A, B, C, D is bounded by small elements of length dx and dy. The force parallel to the x axis across the line $A\ B$ is $-\frac{\delta \phi}{\delta x}$. The flux across $A\ B$ is, then

$$-\frac{\delta \phi}{\delta x} \times \mu \times A\ B \text{ or, } -\mu \frac{\delta \phi}{\delta x}\, dy$$

The flux across $C\ D$ is

$$-\mu \frac{\delta \phi}{\delta x}\, dy - \frac{\delta}{\delta x}\left(\mu \frac{\delta \phi}{\delta x}\, dy\right) dx$$

Thus the total flux entering the area A, B, C, D parallel to the x axis is

$$-\mu \frac{\delta \phi}{\delta x}\, dy - \left\{-\mu \frac{\delta \phi}{\delta x}\, dy - \frac{\delta}{\delta x}\left(\mu \frac{\delta \phi}{\delta x}\, dy\right) dx\right\}$$

$$\text{or, } \frac{\delta}{\delta x}\left(\mu \frac{\delta \phi}{\delta x}\right) dx\, dy$$

Similarly, the total flux entering parallel to the y axis is

$$\frac{\delta}{\delta y}\left(\mu \frac{\delta \phi}{\delta y}\right) dx\, dy$$

Thus the total flux entering the area is

$$\left\{\frac{\delta}{\delta x}\left(\mu \frac{\delta \phi}{\delta x}\right) + \frac{\delta}{\delta y}\left(\mu \frac{\delta \phi}{\delta y}\right)\right\} dx\, dy,$$

and this is zero. Thus, since the permeability μ is unity for air, we have

$$\frac{\delta^2 \phi}{\delta x^2} + \frac{\delta^2 \phi}{\delta y^2} = 0$$

as the equation satisfied by ϕ. This is called Laplace's equation, and is often written

$$\nabla^2 \phi = 0.$$

Now, if $i = \sqrt{-1}$, any function of $x + iy$ will satisfy this equation; for if

$$z = x + iy \text{ and } \phi = F(z)$$

$$\frac{\delta \phi}{\delta x} = \frac{\delta \phi}{\delta z} = F'(z) \text{ say, } \frac{\delta^2 \phi}{\delta x^2} = \frac{\delta F'(z)}{\delta z} = F''(z) \text{ say,}$$

$$\frac{\delta \phi}{\delta y} = i \frac{\delta \phi}{\delta z} = i F'(z), \frac{\delta^2 \phi}{\delta y^2} = i^2 \frac{\delta F'(z)}{\delta z} = i^2 F''(z) = -F''(z),$$

$$\therefore \frac{\delta^2 \phi}{\delta x^2} + \frac{\delta^2 \phi}{\delta y^2} = F''(z) - F''(z) = 0$$

Since a real quantity cannot be equal to an imaginary one, it follows that both the real and imaginary parts of $F(z)$ satisfy the equation separately. Thus, if $\phi + i\psi = F(x + iy)$, where ϕ and ψ are real, ϕ and ψ each satisfy Laplace's equation, and are called conjugate functions of x and y. The system of curves $\phi =$ constant, and $\psi =$ constant, for different values of the constant, always cut one another at right angles, and, if the constants change by equal small increments, divide the space into a system of curvilinear squares. This is easily proved, and is given in all books treating the subject. These two systems form our lines of force and equipotential lines.

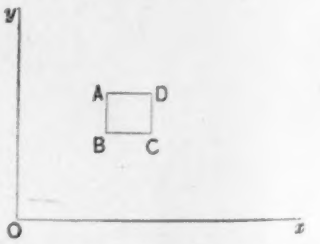


FIG. 9.—DETERMINATION OF FLUX.

Now, if $\phi + i\psi = F(x + iy)$ and x, y, are conjugate functions of x', y', say, $x + iy = f(x' + iy')$, then $\phi + i\psi = F[f(x' + iy')]$ is a function of $x' + iy'$, and, therefore, ϕ and ψ are conjugate functions of x' and y'. If, accordingly, $\phi + i\psi = F(x + iy)$ solves a known problem in the plane of $x\ y$, making perhaps ϕ constant on some boundaries, and ψ constant on others, and if we are able, by

means of the transformation $x+iy=f(x'+iy')$ to convert these boundaries into certain required boundaries in the plane of x' y', we are able to solve a problem in the plane of x' y',—ϕ and ψ taking the same values on these boundaries as on the corresponding ones in the plane of x y.

To take a particular case:

$$\phi + i\,\psi = -\,i\,\frac{\phi_0}{\pi}\,\log\,(\xi + i\,\eta)$$

represents in the plane of $\xi\,\eta$ (Fig. 10), a system of radial lines from the origin (ϕ = constant), and a system of circles about the origin (ψ = constant). We may say it represents the effect of a small source, situated at the origin, discharging on the infinite half plane. Here,

$$\phi = \frac{\phi_0}{\pi}\,\theta,\ \psi = -\,\frac{\phi_0}{\pi}\,\log\,r,$$

where $\xi = r\cos\theta$, $\eta = r\sin\theta$, and therefore, $\xi + i\eta = r\,e^{i\theta}$, where "$e$" is the base of the natural logarithms. Hence, $\phi = 0$ when $\theta = 0$, that is, along the positive part of the ξ axis, (0, ξ), and $\phi = \phi_0$ when $\theta = \pi$, that is, along the negative portion of the ξ axis, (0, $-\xi$).

Now, if we can express ζ, $(\xi + i\eta)$ as a function of z, $(x+iy)$, such that the positive axis of ξ is transformed into the armature face, and the negative axis of ξ into the pole face, we shall be able to solve a problem with the armature and pole face as equipotential surfaces, the pole face being at potential ϕ_0 and the armature at potential zero. For our purpose, we can do as well, and, in fact, better, if we can express z as a function of ζ.

Now, the transformation

$$z=\frac{g}{\pi}\left\{\log\left[\frac{(1-\lambda)^2}{2\lambda}-\zeta-\frac{1}{\zeta}-\left(\sqrt{\zeta}+\frac{1}{\sqrt{\zeta}}\right)\sqrt{\zeta+\frac{1}{\zeta}-\left(\lambda+\frac{1}{\lambda}\right)}\right]\right.$$

$$\left.-i\,\frac{1-\lambda}{\sqrt{\lambda}}\log\left[\frac{2\sqrt{\lambda}}{1+\lambda}\,\frac{\sqrt{\zeta+\frac{1}{\zeta}-\left(\lambda+\frac{1}{\lambda}\right)}+i\,\frac{1-\lambda}{2\sqrt{\lambda}}\left(\sqrt{\zeta}+\frac{1}{\sqrt{\zeta}}\right)}{\sqrt{\zeta}-\frac{1}{\sqrt{\zeta}}}\right]\right\}$$

converts the half plane of ζ (Fig. 10) into the air-gap space, containing a slot, of Fig. 11, making the range of points, $-\xi\,O\,A\,B\,C\,\xi$ of Fig. 10, into the points so marked in Fig. 11.

For, if ζ is negative and real, the first logarithm in z is real, and the second one reduces to

$$i\,\tan^{-1}\left(\frac{1-\lambda}{2\sqrt{\lambda}}\right)\cdot\frac{1+\zeta}{\sqrt{(\zeta-\lambda)\left(\zeta-\frac{1}{\lambda}\right)}}$$

which, multiplied by $-i\,\frac{1-\lambda}{\sqrt{\lambda}}$ is real. Thus, the negative axis of ξ becomes the real axis of x. When ζ is very small, the variable part of the first logarithm becomes log $(-\zeta)$. In passing through zero, ζ changes from $r\,e^{i\pi}$ to re^{0}, or the first logarithm changes from a real quantity to a real quantity, $-i\pi$. Thus, when ζ is between 0 and λ, the imaginary part of z is $\frac{g}{\pi}\times -i\pi$ or $-gi$, that is, the armature face lies a distance g below the pole face.

When

$$\zeta=\lambda,\ z=\frac{g}{\pi}\left[\log\frac{(1+\lambda)^2}{2\lambda}+\frac{1-\lambda}{\sqrt{\lambda}}\,\frac{\pi}{2}\right]-ig$$

When ζ is between λ and 1, the first logarithm has the value

$$\log\frac{(1+\lambda)^2}{2\lambda}-ig+i\tan^{-1}\left\{\left[-\left(\sqrt{\zeta}+\frac{1}{\sqrt{\zeta}}\right)\sqrt{\lambda+\frac{1}{\lambda}-\zeta-\frac{1}{\zeta}}\right]\Big/\left(\frac{(1-\lambda)^2}{2\lambda}-\zeta-\frac{1}{\zeta}\right)\right\}$$

and the second reduces to

$$\log\left[\frac{2\sqrt{\lambda}}{1+\lambda}\,\frac{\sqrt{\lambda+\frac{1}{\lambda}-\zeta-\frac{1}{\zeta}}+\frac{1-\lambda}{2\sqrt{\lambda}}\left(\sqrt{\zeta}+\frac{1}{\sqrt{\zeta}}\right)}{\frac{1}{\sqrt{\zeta}}-\sqrt{\zeta}}\right]+i\,\frac{\pi}{2}$$

Thus the real part of z remains constant, and the line $A\,B$ of Fig. 10 represents the line AB, parallel to the imaginary axis, of Fig. 11.

When ζ passes through 1, the first logarithm remains unaltered, and the second one changes its imaginary part to $-i\,\frac{\pi}{2}$. Hence, the line $B\,C$ of Fig. 10 becomes the other side of the slot. When ζ is between C and ∞, the form of z is the same as when ζ is between O and A.

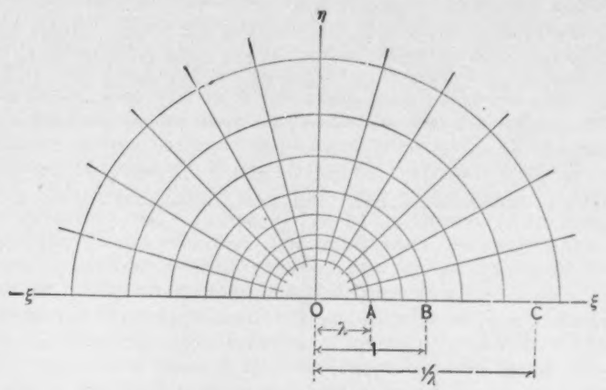


FIG. 10.—PLANE OF ζ

The change in the real part of z between the two sides of the slot is

$$-\,i\,\frac{1-\lambda}{\sqrt{\lambda}}\,\frac{g}{\pi}\,.\,i\,\pi = g\,\frac{1-\lambda}{\sqrt{\lambda}} = b,-$$

the breadth of the slot.

If we write $\frac{b}{g}=p$, the transformation from ζ to z will then become

$$z=\frac{g}{\pi}\left\{\log\left[\frac{p^2}{2}-\zeta-\zeta^{-1}-\left(\zeta^{\frac{1}{2}}+\zeta^{-\frac{1}{2}}\right)\sqrt{\zeta+\zeta^{-1}-p^2-2}\right]\right.$$

$$\left.-ip\log\left[\frac{2}{\sqrt{(p^2+4)}}\,\frac{\sqrt{\zeta+\zeta^{-1}-p^2-2}+i\,\frac{p}{2}\left(\zeta^{\frac{1}{2}}+\zeta^{-\frac{1}{2}}\right)}{\zeta^{\frac{1}{2}}-\zeta^{-\frac{1}{2}}}\right]\right\}$$

Now, $\phi + i\,\psi = -\,i\,\frac{\phi_0}{\pi}\,\log\zeta$, which we can write

$$\zeta = e^{i\pi\,\frac{\psi+i\psi}{\phi_0}} = e^{X+iY}\quad\text{say.}$$

Substituting this in the equation for z, we get

$$z=\frac{g}{\pi}\left\{\log\left[\frac{p^2}{2}-e^{X+iY}-e^{-(X+iY)}-\left(e^{\frac{1}{2}(X+iY)}+e^{-\frac{1}{2}(X+iY)}\right)\sqrt{e^{X+iY}+e^{-(X+iY)}-p^2-2}\right]\right.$$

$$\left.-ip\log\left[\frac{2}{\sqrt{(p^2+4)}}\,\frac{\sqrt{e^{X+iY}+e^{-(X+iY)}-p^2-2}+i\,\frac{p}{2}\left[e^{\frac{1}{2}(X+iY)}+e^{-\frac{1}{2}(X+iY)}\right]}{e^{\frac{1}{2}(X+iY)}-e^{-\frac{1}{2}(X+iY)}}\right]\right\}$$

Thus, if we give values to ϕ and ψ in this equation, we find the coordinates $(x\,y)$ of the point where the equipotential line on which the potential has the value given to ϕ, crosses the line of force where the flux function takes the value given to ψ. In this way the system of lines of force and equipotential lines shown in Fig. 10 is transformed into a system similar to Fig. 4, the chief difference being that, for convenience of representation, the constant λ is chosen as ½ in Fig. 10, giving $b/g = 1/\sqrt{2}$, whilst in Fig. 4, $b/g = 3$, or λ is approximately 1/11. In fact, Fig. 10 transforms into the slot shown in Fig. 11, and the system of lines of force and equipotential lines of Fig. 10 transforms into the system appropriate to this slot, but will be denser than in Fig. 4, for which the corresponding radial lines would be 36 degs. apart instead of 15 degs., the circles being spaced to suit.

Having obtained a diagram of lines of force, all information about

the magnetic field follows. For instance, the equivalent layer of attracting matter required to produce the field has a surface density $\frac{1}{4\pi}$ times the force at the surface over which it is spread, being positive when the force is inward, and thus it varies in a complicated manner over both the armature and pole face.

It will be seen that even an ideal case is not an easy subject for calculation, while an exact solution of the usual practical cases is quite beyond us. In order that theory may be any use to us at all in

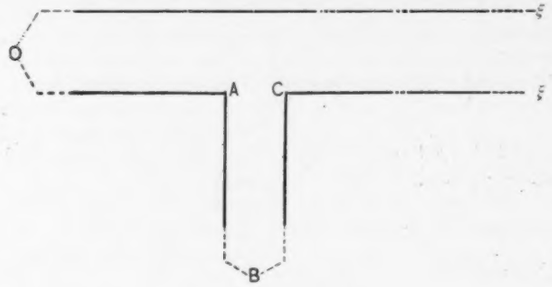


FIG. II.—PLANE OF Z.

this connection, we must arrange that any problem we solve really resembles in some part, a practical problem, and then take care that whatever deductions we make from our solution for actual use are so expressed as to depend on that portion of the solution which resembles the practical case.

Changes in Arc Lighting.

BY ALTON D. ADAMS.

ARC lighting for streets and private service is now done by not less than seven distinct varieties of lamps. Five of these varieties operating with direct current are single open series arc, single open multiple arcs, single enclosed series arcs, single enclosed multiple arcs, and double open series arcs. Alternating currents operate single enclosed series arcs, and single enclosed multiple arcs. As to costs of operation and methods of distribution these lamps differ widely. Because of this some of the varieties have largely displaced others in the past, and like changes are still going on. Single open arcs, distributed by series circuits from constant, direct-current dynamos were the first to enter the lighting field, a little more than two decades ago. This type of lamp usually operates with current of 6 to 10 amperes, according to the degree of illumination desired, and 45 to 50 volts at the arc. A very large per cent of the energy delivered to these lamps is available at the arcs, as the coils of the regulating magnets consume only trifling amounts. In most instances it has not been found desirable to increase the pressure of series arc circuits beyond about 3500 volts, thus providing for approximately 60 open arcs and a considerable line loss. The pressure last named with 10 amperes flowing represents only 35,000 watts, which is thus a common limit to the individual capacity of arc dynamos. Such a limit is exceeded in some cases by operating more lamps per circuit, or by the construction of dynamos intended to operate several independent circuits each.

Street lighting has been a very large part of arc lamp service from its inception, and the expense of operation for single open arcs is especially heavy for this line of work. During a large part of each year street lighting must be done for 10 to 12 hours per night. As a single pair of carbons is consumed in 6 to 8 hours of operation, the single open arc must usually be trimmed during the night for street service. The use of double instead of single open arcs for streets saves fully one-half the labor of trimming, because much more time is required to go to each lamp than to fix the carbons when there, and the work cannot be done as rapidly at night when there is energy on the line, as during the daytime when the circuits are dead. For commercial service the advantage of double over single open arcs is much less, because such service seldom requires more than one pair of carbons per lamp per night, and a trimmer must usually make the rounds daily in any event. While arcs on series circuits are available for both street and commercial service, they are especially adapted to the former, because of the ease with which they may be distributed over wide areas. On the other hand, arcs in multiple are subject to the limits of low pressure circuits, but may be operated from the same supply with incandescent lamps, and are thus well suited to the requirements of commercial service. As multiple arcs of either the direct or alternating type may be operated by large generators that also supply incandescent lamps and motors, they are a much more desirable load than series arcs. With multiple arcs 15 to 25 per cent of the energy taken from supply lines must be expended in resistances connected with each lamp because of the pressures at which incandescent lamps and motors are operated. Such resistances must in any event consume 10 to 15 per cent of the energy delivered for multiple arcs, in order to insure steady working of the lamps.

The most important differences between open and enclosed arcs, whether of the alternating or direct current variety, are the increased voltage of the latter, and their longer service with a single pair of carbons. Enclosed arcs require 75 to 95 volts between the carbon points of each lamp, or nearly twice the pressure necessary for the open variety. One pair of carbons in the enclosed arc lamp lasts roughly fifteen times as long as in an open arc. For distribution on series circuits the higher voltage of enclosed arcs is a decided disadvantage, because little more than one-half as many lamps can be operated on a single circuit as is possible with open arcs. On the other hand, the higher voltage of enclosed arcs is often an advantage where they are operated on circuits of constant pressure, because a single lamp can be supplied from 110-volt mains with much greater economy than is possible with open arcs. The great advantage of enclosed arcs that more than offsets any disadvantages they may have is the saving which they effect in the cost of carbons and labor for trimming.

The several classes of arc lamps have come upon the scene one after another, and the effect of each type in displacing previous sorts has been due much more to possible economies of operation than to capacities for superior service, though this latter has not been lacking.

With the qualities of the several classes of arc lamps in mind it is possible to detect the reasons that have determined the numbers of each type in use for streets and commercial purposes since the inception of the industry. Beginning with 1888 the number of each kind of arc lamps operated by electric lighting stations in Massachusetts has been recorded for each fiscal year in the public records of that State, and the figures here presented are derived from this source. From the table it appears that the total number of arc lamps supplied from lighting stations has constantly increased for each of the 12 years from 1888 to 1900. In the former year the number operated was 6579, and in 1900, 23,355, a gain of 255 per cent. Commercial arcs have fallen behind the rate of gain made by the total for all purposes, their number having been 3258 in 1888, and 9893 in 1900, an increase of 200 per cent for the period.

Arc lamps operated by electric stations.

Year ending June 30.	Total arc lamps.	Commercial arc lamps.	Arc street lamps.
1888	6,579	3,258	3,321
1889	8,827	3,928	4,899
1890	9,999	4,492	5,507
1891	11,868	5,004	6,864
1892	14,097	5,600	8,497
1893	15,583	5,846	9,737
1894	16,602	6,593	10,009
1895	17,313	6,653	10,660
1896	18,714	7,614	11,100
1897	19,529	7,834	11,695
1898	19,847	7,743	12,104
1899	21,253	8,161	13,092
1900	23,355	9,893	13,462

Arc street lamps, on the other hand, have increased in numbers at a greater rate than the total for all purposes, having stood at 3321 in 1888 and at 13,462 in 1900, a gain of more than 300 per cent.

For each year the number of arc street lamps has been divided by the total number of arc lamps to determine the per cent in street service.

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Year ending June 30.	Per cent street lamps.	Year ending June 30.	Per cent street lamps.
1888	50.4	1895	61.5
1889	55.5	1896	58.8
1890	55.0	1897	59.8
1891	57.8	1898	60.9
1892	60.2	1899	61.6
1893	62.4	1900	57.9
1894	60.2		

From these results it appears that the per cent of street lamps to the total arcs in use increased from 50.4 in 1888 to 61.6 in 1899. During these eleven years the rise in the proportion of street lamps suffered two checks—one in 1894 and another in 1896.

From 1899 to 1900 the relative number of street arcs fell rapidly and stood at 57.9 per cent in the latter year. Before the reasons for these changes can be traced, the number of each type of lamp operated in different years must be considered. The table presents the numbers of single and double open and of enclosed arcs in use each year, for both street lighting and commercial purposes.

The single open arcs present a striking illustration of rise and decline. Starting with 4392 in 1888 the number of this type of lamp reached 7056 in 1893, was at 7485 in 1898, and dropped to 2915 by 1900.

Types of arc lamps operated by electric stations.

Year ending June 30.	Single open arcs.	Double open arcs.	Enclosed arcs.
1888	4,392	2,187	.....
1889	5,452	3,375	.....
1890	5,364	4,635	.....
1891	5,753	6,115	.....
1892	6,574	7,523	.....
1893	7,056	8,527	.....
1894	7,286	9,316	.....
1895	6,929	10,384	.....
1896	7,159	11,555	.....
1897	7,385	12,144	.....
1898	7,485	12,362	.....
1899	5,096	11,857	4,300
1900	2,915	8,452	11,988

For the year of 1888 the number of double was less than the number of single open arcs, because the former came into the market later. The rise of the double arcs was the more rapid and the maximum number greater, but attained in the same year as that of the single open arcs. In 1888 the double arcs numbered 2187, and the maximum of 12,362 was reached in 1898. After this later year the number of double arcs declined, though not as rapidly as the single type and stood at 8452 in 1900. Enclosed arcs began to be used about 1897, but their numbers do not appear in the records until 1899, when the total was 4300. By 1900 this total had more than doubled, and stood at 11,988 in that year.

Increase in the number of arc lamps for each year.

Year ending June 30.	Commercial arc lamps.	Arc street lamps.	Single open arc lamps.	Double open arc lamps.
1889	670	1,578	1,060	1,188
1890	564	608	*88	1,260
1891	512	1,357	389	1,480
1892	596	1,633	821	1,408
1893	246	1,240	482	1,004
1894	747	272	230	789
1895	60	651	*357	1,068
1896	961	440	230	1,171
1897	220	595	226	589
1898	*91	409	100	218
1899	418	988	*2,389	*505
1900	1,732	370	*2,181	*3,405

*Decrease.

To bring out more clearly the reasons for the increase or decrease in the number of each type of lamp, the additions to commercial, street, single open and double open arc lamps are given in the table for each year. From 1888 to 1898 the number of commercial arcs increased 4485, but during the same period only 3093 single arcs were put into use, so that 1392 double arcs must have been required for commercial purposes, even if no single arcs were used in the streets. During the decade just considered 8783 street lamps were put into operation throughout the State, and the number of double arcs added for all purposes was 10,175. This leaves an excess of 1392 double arcs above the requirements for street lamps, or just enough to make up the difference between the numbers of commercial and of single arc lamps. As a matter of fact, while the demands of street lighting were mainly supplied by double arcs, it is probable that a few of the single lamps were used for this purpose. In only four years, between 1889 and 1900, was the number of single open arcs put into operation sufficient to meet the demands of commercial service. The largest additions of single arcs during this period were made from 1891 to 1897, when single multiple arcs were being applied rapidly to commercial service. The figures for the yearly increase of arc lamps show only the net additions. The decade from 1890 to 1900 saw a large displacement of series by multiple open arcs in commercial service, but this movement is not indicated in the table.

In each of five years between 1889 and 1897 the addition of double arcs was greater than the requirements for street lighting, and in the three years where demands for street lamps exceeded the additions of double arcs these excesses were relatively small. The year 1898 saw a great decline in the addition to the numbers of both single and double open arcs, less than one-half of the usual number of the former and less than one-quarter of the usual number of the latter being put into service during the year. For each year up to and including that last named the sum of street and commercial arc lamps is just equal to the sum of single and double open arcs, because the number of street lamps in each case is found by the subtraction of the number of commercial lamps from the sum of single and double open arcs. It is possible that the numbers of street lamps for the years 1897 and 1898 are less than they should be, because the state reports do not show the numbers of enclosed arcs separately for these years, and it is not clear that they were included in the numbers of open arcs.

The year 1899 evidently marks a new era in the applications of arc lighting. For that year there was an increase of 1406 in the total number of arc lamps used for all purposes, and at the same time the open arc lamp declined by 2894. The demands for increased service as well as the falling off of the single and double open lamps was met by an addition of 4300 enclosed arcs. Changes for the year of 1900 were even more radical than those just described. In this year the arc lamps added for street lighting and commercial service numbered 2102, while the decrease of single and double open arcs was 5586. Enclosed arcs to the number of 7688 were put into service meantime to replace the open arcs thrown out of use and meet the new demand. During the two fiscal years just considered 4570 single and 3910 double open lamps were replaced by enclosed arcs. In the absence of any other reasonable cause it seems certain that the enclosed arcs have largely increased the demand for arc lighting. During the four years from 1894 to 1898 the number of arc lamps in use for all purposes increased by 3245, but in the two years from 1898 to 1900 the like increase was 3508 arc lamps, making the yearly rate twice as great on an average in the later as in the earlier period. For the year of 1900 the number of arc lamps in use for all purposes increased by 2102, a number equaled by additions in previous years only by those for 1889 and 1892. In these two earlier years street lighting was making rapid advances by means of double arcs, and more than 70 per cent of the lamps added in each year were devoted to this purpose. On the other hand, for 1899 and 1900, only 38 per cent of the added arcs were street lamps. From this it seems that the especial influence of enclosed arcs has been to stimulate commercial service. Six years between 1892 and 1898 saw an increase of 2143 in the number of commercial arc lamps, and the two following years gave a further increase of 2150 arcs in the same service. Evidently the enclosed arc stands a much better chance than the open type in competition with incandescent lamps for interior illumination.

The substitution of enclosed for open arcs has a strong tendency to modify distribution lines and generating stations. With enclosed arcs the number of series lines may be double, or the maximum voltage of each line twice that necessary for an equal number of open arcs. This makes it more desirable to supply street as well as commercial arcs from constant pressure circuits wherever possible than was the case with open arcs. In the supply of private consumers the change from open arcs on series circuits to enclosed arcs on constant pressure circuits is already far advanced.

Even where series distribution is retained for enclosed arcs in

street service, there is a tendency to shift them from direct to alternating current. This tendency is stronger with the enclosed than with open arcs, because the illumination from the former is satisfactory, where the alternating current is used. The movement of arcs from series to multiple circuits, and from constant direct to constant alternating current lines retarded the increase in capacity of constant current dynamos throughout the decade from 1890 to 1900. Exact figures cannot be given on this point, but it is a matter of general knowledge that multiple have largely displaced series arcs in commercial service, and the per cent of arc street lamps to the total reached its highest point at 62.4 in 1893. For the year of 1900 the total capacity of arc dynamos throughout the stations of the State declined 193 kilowatts. Of the 4300 enclosed arcs reported for 1899, 3313 were in use at Boston, leaving 987 for the remainder of the State. In 1900 the number of these lamps at Boston was 6682, and the rest of the State had 5304. Thus while the enclosed arcs in use at Boston were doubled in number, those outside were multiplied by six.

Power Transmission on the Susquehanna.

BY O. P. WATERS.

THE largest plant of the kind in Pennsylvania which has ever gone in, and perhaps second only in importance to the great Niagara power plant, is now in the course of construction at York Haven, on the Susquehanna River, about 16 miles from Harrisburg, and 11 miles from York, Pa. The work began June 17, 1901, and will likely be completed in the fall of 1902. The operation consists in the development of an immense electrical power plant, gained by impounding and utilizing the entire body of water at the Falls, a point on the Susquehanna River, just a short distance above the plant.

There will be built a power house 478 ft. long and 51 ft. wide, in which there will be 40 turbine waterwheels of 600 horse-power each, operating twenty 750-kw generators, together with two turbines of

VIEW OF FALLS ON SUSQUEHANNA RIVER.

250 horse-power each to drive machines for excitation. A contract for the generators has been awarded to the Stanley Electric Manufacturing Company, and for the turbines to Robert Poole, Sons & Co., of Baltimore.

From this building there is being built a granite wall 3500 ft. long, and from 26 to 38 ft. high, 16 ft. at the top and 19 ft. at the bottom. This will enclose a race 375 ft. in width, 16 ft. in depth, connecting with the dam at the head of the Falls. The construction of the wall will require 100,000 cubic yards of masonry. A cofferdam has been erected 550 ft. in length and 240 ft. in width, in the construction of which 45,000 bags of sand, 250,000 ft. of timber and 10,000 cubic yards of stone were used. Inside of this cofferdam the foundation for the power house has been excavated in solid rock, and the work of laying masonry is being pushed with all possible energy. Twelve derricks, with the latest improvements in hoisting apparatus, have been placed, and a portable railway laid reaching all points at which masonry work is in progress, comprising a length of nearly two miles, and supplied with complete equipment for transportaion of material and supplies used in the work.

The promoters and principal owners of this company are Mr. Henry L. Carter, of New York, and Judge W. F. Bay Stewart, York, Pa. In addition to the lands required by them for the proposed development they have purchased 450 acres lying contiguous to the developing property and to the Northern Central Railway, on which it is expected a large portion of the current generated will be used to drive large industries which are already negotiating the power.

The company has been capitalized at $3,000,000 and a bond issue has been made of $1,500,000. It will take all of this latter sum to complete the work. The plans have been laid out by Major George S. Burbank, consulting engineer, who was connected with the Niagara power plant. Contractor Thomas Green, of York Haven, is superintending the work of construction, while H. B. Montgomery is the business manager.

An exceptionally favorable feature in connection with this construction is the fact that all of the granite used in the erection of the building, etc., will be taken from a quarry located but a few yards from the place. It is of excellent, durable quality.

"Distribution" Discussion by the American Institute of Electrical Engineers.

THE November meeting of the American Institute of Electrical Engineers was held last Friday simultaneously in New York and Chicago, and no less than eight papers were presented. As the amount of matter contained in the papers would cover about 15 of these pages, it is only possible within the space at our disposal to give a brief summary of the more salient features of the contents. The papers in the aggregate deal in a most thorough manner with the question of electrical distribution in cities, and to those particularly interested in this subject, their reading in full is to be recommended. The paper of Mr. W. L. R. Emmet on "The Distribution by the Three-Phase System and the Operation of Single-Phase Circuits by It," will be printed in a following issue.

A paper somewhat aside from the subjects discussed in the others read is a short one by Mr. Henry G. Stott on "Locating Faults in Underground Distribution Systems." Mr. Stott shows that with the large cables used in city distribution, the application of the resistance or loop method is impracticable. He then discusses three other methods which have been applied. One is denominated the "cut-and-try" method, which consists in cutting into as many sections as necessary until the fault is finally located. This is characterized as a slow, expensive and unscientific method which can only be used as a last resort. The second or "smoke" method consists of putting a current of sufficient magnitude into the cable to cause the insulation at the fault to burn and give out volumes of smoke, by means of which the location of the burned section may be discovered upon opening up the manholes. Mr. Stott considers this method also crude, since the flames may burn not only a great length of the cable itself, but also other cables, or cause explosions from the ignition of the gases ever present in city conduits.

The third, or compass method, Mr. Stott considers to be the only practicable and safe means of quickly and accurately locating a ground in cables of large cross-section. This method consists, briefly, in sending a direct current of about 10 amperes into the cable through the ground, the current first passing into an automatic reverser which changes the direction of the current flow every ten seconds. A manhole is then opened near the center of the cable length and a pocket compass is laid on the lead sheathing of the cable and observed for, say, half a minute. If the ground is further from the source of reversed current the compass needle will swing around approximately 180 degs. upon the reversal of flow at the end of each 10-second interval. The compass is then applied at another manhole, say, a mile further away, and if no motion of the compass needle occurs, then the fault has been passed and another manhole is opened between the first two positions, and so on until the fault is finally located in a section between two manholes.

The paper illustrates and describes a form of reverser used by the Manhattan Railway Company, which consists of a ¼-hp three-phase induction motor geared to a two-part commutator which revolves in oil in order to insure the quick reversal of current without danger of arcing across segments. Current may be obtained from an arc light machine preferably, or from a 500-volt circuit.

The paper by Mr. Emmet, which will be reprinted in full in a following issue, advocates the use of three-phase machines in general for alternating-current generation in central stations, even where the distribution is single-phase. Two-phase and single-phase machines he considers to have, in the great majority of cases, no good reason for existence. A three-phase machine, as ordinarily designed and with a star-winding, will carrying from 75 per cent to 85 per

cent of its rated load in single-phase current between two conductors with the same heating which would be produced by operation at its rated capacity with balanced three-phase current. If motors or rotary converters are connected to a three-phase generator which is operating with single-phase load, these motors or converters will tend to equalize the load between phases and thus may increase the capacity of the system. When a three-phaser is partly loaded with single-phase currents between two of its wires, the unused phases may naturally be loaded with other single-phase currents, thus giving various degrees of unbalancing between the three phases and, with normal heating, will vary from 75 per cent to 100 per cent of the total three-phase capacity. As to relative cost, a three-phase machine for a given single-phase output has about the same size and cost as the machine designed for single-phase alone, the apparent inconsistency lying in the fact that a three-phaser for a given output is cheaper and smaller than a single-phaser.

The paper enters into the details of single-phase distribution from three-phase machines, and contains diagrams of several types of distributing circuits.

A paper by Mr. Harold W. Buck describes the Buffalo high-tension distribution system. Three overhead circuits, each having a capacity of 10,000 horse-power at 7 per cent line loss, enter a terminal house in Buffalo, where the transmission voltage of 22,000 is cut down to 11,000. From here power is transmitted at 11,000 volts by cables drawn through tiled ducts under the street, to seven sub-stations. The methods are described which are employed in this part of the distribution for transferring from one cable to another, and for cutting out damaged sections of a cable by means of section switches, which latter are installed in vaults under the city streets. It is stated that these switches have proved a great convenience at times when repairs have been necessary on sections of the cables, and for locating faults without the necessity of cutting the cable.

Of the seven sub-stations, one receives 2000 horse-power for railway purposes with a current that is transformed by converters from 11,000 volts three-phase to 360 volts direct. This same sub-station also receives 1000 horse-power for general power distribution at 2200 volts. Four other sub-stations are for railway service, the amount of power received being 1500, 1000, 1500 and 1000, in each case the three-phase, 11,000-volt current being transformed by converters to 360-volt direct. The largest of the seven sub-stations receives 5000 horse-power, which is transformed from 11,000 volts three-phase to 360 direct, and fed to the plant of the Buffalo Lighting Company in an adjacent building. One thousand horse-power is also supplied from this station at 2200 volts, three-phase, for general power distribution. The remaining station receives 2000 horse-power, which is transformed to 2200 volts, three-phase, for power distribution.

As to the reason for distributing to sub-stations at 11,000 volts instead of at the transmission voltage of 22,000 volts, Mr. Buck says that while there have been examples of the successful operation of underground cables at voltages even higher than 22,000, nevertheless what can be done on a through direct line cannot be safely done on a network. The Buffalo underground system is essentially a network, and he believes that 11,000 volts is, in the present state of the art at least, the highest voltage which should be considered for this class of service. The success of the Buffalo distribution of 11,000 volts has, however, demonstrated the safety and feasibility of using a potential as high as this, and seems to show that there is no longer any reason for adhering to the prevailing voltage of 6600 for underground work. One of the advantages of the higher voltages is that in case of short circuits in the cables, practically no damage is done at 11,000 volts on account of the small current, while a similar short-circuit at 6600 volts would undoubtedly blow the cable to pieces on account of the greater current, the heat energy at the fault being nearly four times as great. Another advantage for changing from 22,000 to 11,000 volts at the city line is that it renders the 11,000-volt cable system independent of grounds and high-voltage disturbances which occur at times on the transmission line, since there is only an inductive connection between the two systems.

Mr. Buck considers that from a business as well as an engineering standpoint the division of power supply among three companies is desirable. In Buffalo there is a distributing company called the Cataract Power & Conduit Company, which purchases power generated by the Niagara Falls Power Company and delivered at the Buffalo city line, which it distributes as raw material to the railway and to the lighting and power company for redistribution to consumers.

In a paper entitled "Alternating Current as a Factor in General Distribution for Light and Power," Mr. Charles F. Scott considers the question whether for general distribution for lighting and power service, and where the current is generated in alternators, it is desirable to utilize the current as alternating current or to convert it into direct current. After considering the various factors that enter into the quesion, Mr. Scott concludes that all of the important classes of service for which current from a central station is used may be successfully undertaken either by the direct current or by the alternating current, sometimes equally well, sometimes with the advantage on one side and sometimes with the advantage on the other side. The most important difference is probably in the case of variable speed motors and the importance of this will depend quite largely on the proportion of this kind of service. Although the alternating-current motor cannot exactly replace the direct-current motor, so that there may be some inconvenience in changing from one system to the other, yet when a new plant is being laid out, it is probable that the cases are very rare in which it would not, on the whole, be practicable to utilize either alternating-current motors or direct-current motors.

Considering next the matter of apparatus, the greater simplicity of the alternating-current system is brought out in its several aspects. Referring to the storage battery as an element which is sometimes presented as a reason for adopting direct current, Mr. Scott points out that it may be readily added to the alternating-current system through the employment of a rotary converter for charging the battery, which latter in turn supplies current through the converter to the alternating circuit.

Mr. Scott concludes that the general comparison evidently favors the one which employs alternating current only. The introduction of converting apparatus, therefore, must be justified by the advantages accruing in connection with the utilization of the current which is sufficiently great to overbalance the extra cost and compensation. There are, however, some cases where combined service is advantageous, alternating current being supplied for certain districts and direct current for others. In cities a combined service for general distribution is sometimes applicable for furnishing direct current from sub-stations to districts which have previously been supplied by direct-current generating plants, while alternating current is furnished to the outlying parts. The same generators may be used for both classes of service and may supply them simultaneously. Quite similar results may be obtained from a direct-current generating plant, the alternating current being obtained from inverted rotary converters. In smaller towns in many cases the lighting and railway work can be operated from the same alternating-current busbars, an automatic compounding of the rotary converters being suggested so as to make the voltage upon the general system sufficiently constant for lighting service.

In conclusion Mr. Scott considers that probably the most pertinent conclusion to be drawn from a discussion of this kind is that there is no ideal system and no panacea plan which can be unanimously applied. Existing and local conditions, special requirements and the relative importance of the various classes of service to be rendered, must all be taken into account in determining what will be adequate in an individual case.

Mr. W. S. Barstow contributed a paper entitled, "Notes on the Alternating-Current System of Distribution." Among the reasons which Mr. Barstow introduces as to why the alternating-current system has not yet attained the status of a large distributing system for compact territory, are the indispensable part which the storage battery has come to play in the general system; the lack in the past of an alternating-current motor for general power purposes, and lack of standardization of alternating-current systems, and the difficulties that have been met in paralleling transformers. The alternating-current system, he considers, is, however, alone in its field of transmission and house-to-house supply in scattered territories, but even in entering these fields too much attention cannot be paid to the condition of future permanent supply, there being many cases where the system has been used only as a temporary expedient for developing territory.

In conclusion, Mr. Barstow states that if the alternating current, besides retaining its field of transmission and scattered distribution, where it is supreme, would enter the compact direct-current field of distribution, there are required: First, a standard type of motor which can be used for all classes of business demand, and will meet the same commercial requirements as the present direct-current motor. Second, a universal system of supply which does not re-

quire transformers or anything outside of the meter to be located on the premises of the customers. Third, some apparatus which, in connection with alternating current, will take the place of the storage battery supply on the direct current. With these requirements complied with he considers that alternating-current distibution can expect to take the place of many of the large direct-current systems, not only for the supply of light and power, but also for transportation.

In a paper entitled "Distribution of Electrical Energy in Large Cities," Mr. Louis Ferguson describes the system employed in Chicago, and also refers to similar systems now employed in Milan and Berlin. Mr. Ferguson recommends direct current for the lighting and power work in the strictly business and city residential districts, and alternating current for the less closely built residential districts, as well as for the actual suburban territory of the city. He gives an analysis of the lighting and power output of Chicago central station companies where this method of distribution is followed. Out of a total maximum output of 22,500 kilowatts, 23.4 per cent is by 60-cycle alternating distribution for a territory of approximately 58 square miles, and 79.5 by direct-current distribution over a territory of only 10 square miles. In the latter case a considerable part of the direct current is supplied by direct-current machines operated at 25 cycles. With the growth of the business of the company all direct-current generating apparatus will be superceded as it wears out or becomes obsolete, by 25-cycle rotary sub-station distribution in one low-tension district. As outlying residence districts become more general consumers of electricity they are changed over to low-tension direct-current, and all new development in the northern and western Chicago districts is supplied by motor-generator sets receiving 25-cycle current from a main generating station and delivering 60-cycle current to the distribution lines.

Mr. Ferguson considers that the feasibility of applying the direct-current motor to general power work is much superior to that of the alternating-current motor, and the disturbing effects of line pressures are less. The initial cost of the direct-current motors and their accompanying equipment is very much less, and he adds that at the present time the selling price of three-phase motors in America is far in excess of being reasonable. Direct current is also very much better adapted than alternating current, to electric elevator work, and to illustrate the importance of the electric elevator to the central station, the statement is made that in Chicago elevator motors alone take 12½ per cent of the total output of the companies. In connection with the advantage of direct current he refers to the great value of the storage battery on electrical distribution systems. The battery capacity of the Chicago Edison Company is distributed over the entire low-tension district, having a combined capacity at the eight-hour rate of 6600 ampere-hours, not including smaller batteries in three of the rotary sub-stations in residence districts.

Having determined that direct-current distribution is most desirable for the central district of Chicago, the system of generation for the principal stations was adopted which was considered the best adapted to direct-current distribution. This consists in the use of rotary converter sub-stations and the generation of 25-cycle, three-phase alternating current by double-current machines at 160 volts alternating, arranged for stepping-up to 4500 and 9000 volts. In one of these stations the largest double-current machine thus far built has been installed, having a normal capacity of 2500 kilowatts with an overload limit for peak work of 3200 kilowatts, and generating 300 volts direct current and 180 volts three-phase. This machine is run in parallel with the other double-current and direct-current machines in the station, and will also operate in parallel with a new 3500-kw. three-phase alternator now being located beside it to generate 9000 volts. It is stated that the limit of available space in the principal plants having been reached, it is probable that all additional generating plants will consist of 25-cycle, three-phase alternators generating 9000 volts. The efficiency of transmission and transformation between three-phase generators and rotary direct-current for the entire sub-station system, is 82.2 per cent.

Mr. Ferguson states that the method of generating all alternating current in one or two large stations and transmitting the energy at high voltage to sub-stations for conversion to direct current in thickly settled districts, is now being adopted in some of the large and most progressive cities of Europe, notably in Milan and Berlin. The paper gives an account of the recent plants installed on this system in these cities.

Mr. Philippo Torchio, in a paper entitled "250-500-Volt, Three-Phase Wire Distribution for Lighting and Power," advocates the use of the three-wire, 500-volt system, which he states has all the advantages of the original low-tension Edison three-wire system, and has greater capabilities of expansion in lightly loaded or scattered territories, as in the case of small cities or in large factories and in other places. Three points that have been urged against this system are the greater tendency to arc, thereby necessitating the use of special fittings and insulation; the lower efficiency of the 250-volt incandescent lamp, and the difficulty of operating 250-volt arc lamps.

As to the first point, this can be provided for by the use of proper insulation and the design of proper fittings. As to the lower efficiency of the lamp, this is only a matter of moment where low-voltage lamps are at present used, for outside of large cities the 3.6-watt lamp is quite common, and there will be thus an advantage in replacing it with a 3.4—3.5 high-voltage lamp. As to arc lamps, the difficulty has been overcome by connecting two ordinary enclosed arcs in series, and lately several types of double arc lamps have been used with entire success. In conclusion, Mr. Torchio considers that the difficulties to be overcome are not very serious, especially for new installations and where changes of distribution are contemplated.

A table is given, showing that the saving from the use of the high-voltage system will be very large for lightly loaded districts. With a 500-volt, three-wire system a sub-station can in each case supply for the same current density in the feeders and the same regulation, a territory four times as large as with a 250-volt, three-wire system. While thus no feeder saving is effected, a large saving will be made by the reduction of the number of sub-stations, and their operating expenses, of which estimate is given in the second table. This saving ranges from $100 per kilowatt maximum, where the load is 2.5 watts per foot of street covered by mains, to $14.40 for a load of 80 watts, no large motors being used; if large motors are used these figures become $162.50 and $19.40, respectively.

Professor W. L. Robb, in a paper entitled "Distribution of Electricity in Cities of Moderate Size," considers that in view of the conditions existing in business sections of the cities of this class, and the relatively high price charged at present for alternating-current arc lamps, motors, etc., it is desirable, at the present time, to supply the business section of a city of the class considered in the paper, with direct current, and he favors the three-wire, 220-volt system as against the high-voltage, three-wire system.

The power house should be situated with respect to the cheap production of electricity, and, therefore, not in the business district. Current for this district should, therefore, in general, be supplied from a rotary converter sub-station situated as near as possible to the center of distribution of the district. The main power house should generate only alternate current, which should have a frequency of 60 cycles, be a three-phase, four-wire system and have a pressure of approximately 2300 volts between each phase wire and the common wire. The feeder should be lead-covered cables drawn into conduits. Professor Robb considers that paper insulation is more satisfactory as well as cheaper for feeders than rubber insulation. In order that a system of alternating-current distribution of any size should be satisfactory, it is necessary that the arrangement of the generating plant be such that current can be supplied to the different feeders at different pressures, which may be accomplished by boosting transformers in each feeder circuit and by a system of pressure wires from the various centers of distribution, or by automatic devices such as originated by Mr. W. L. R. Emmet.

Reciprocity Resolution Adoped at Washington.

The net result of the proceedings of the National Reciprocity Convention held at Washington last week appears to be summed up in the following resolutions:

Whereas, The growth of manufactures in the United States, represented in values and in round numbers, has been as follows: 1850, $1,000,000,000; 1860, $2,000,000,000; 1870, $4,000,000,000; 1880, $5,000,000,000; 1890, $9,000,000,000; 1900, $15,000,000,000; and,

Whereas, These figures exhibit at the same time a splendid result for the past industrial policies of our Government, and a growing need for the development of larger markets in foreign countries; and,

Whereas, It would seem desirable not only to maintain policies under which such splendid results have been accomplished, but also devise means to develop increased markets for the increased and increasing manufactured products; therefore, be it

Resolved, That this convention recommends to Congress the main-

tenance of the principle of protection for the home market and to open up by reciprocity opportunities for increased foreign trade by special modifications of the tariff, in special cases, but only where it can be done without injury to any of our home interests of manufacturing, commerce or farming.

On the whole, it may be said that the protectionists captured the convention bodily. Before adjourning, the convention adopted resolutions in favor of the proposed Department of Commerce and Industries.

The Morton Current.

At the annual meeting last year of the American Electrotherapeutic Association, upon the motion of Dr. W. J. Morton, a committee was appointed, consisting of Dr. W. J. Herdman, of the University of Michigan, and Mr. W. J. Jenks, to report on a question of priority concerning a method of producing from static apparatus what has been claimed to be a new form of undulatory or oscillatory current, which sometimes has been referred to as the "Morton current."

It appears that Dr. A. D. Rockwell had in letters to a medical journal contested the priority of Dr. Morton in the discovery of a new so-called static induced current and means of producing the same. In his articles he said that in a book by Mauduyt published in Paris in 1783 is given "both in descriptive and illustrative detail what is now called the 'static induced current.'" Referring also to Tibbett's "Handbook of Medical Electricity," published in London in 1873, he says: "Dr. Morton has simply copied in its essential details this illustration, or some similar one from earlier French or English issues—Mauduyt, Wilkinson, Adams or Cavallo—and given to the current that these old fellows used the name of 'static induced.'" Again, referring to Adams' "Essay on Electricity," published in London in 1792, and to an illustration therein, he says: "These are nothing more nor less, could be nothing more nor less, than what Dr. Morton calls his wonderful discovery of 'static induced currents and physiological tetanus.'"

The report in considering the question of priority goes into considerable detail and includes three illustrations, of which reproductions are given herewith. Fig. 1 illustrates Cavallo's method of about 1780; Fig. 2, Duchenne's method of 1872, and Fig. 3 outlines Morton's method of 1880-81. Referring to Fig. 1, the circuit of discharge of the Leyden jar condenser is completed through the patient and the spark-gap, which are in simple series. Commenting on this arrangement, the report says that the patient thus receives the direct shock of the discharge and all of the current which causes the spark. A Lane electrometer is used to regulate the frequency and force of each shock. In this method the static generator is constantly revolved.

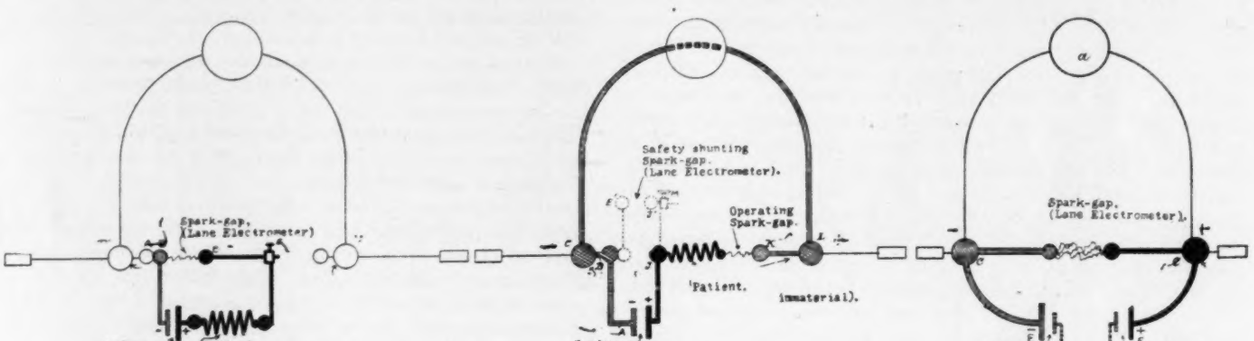
Fig. 2 indicates Duchenne's method of 1872. Here the circuit of the discharge of the Leyden jar condenser is completed through the spark-gap and the generator, all three of which are in simple series. Commenting on this arrangement, the report says that with it the patient receives the direct shock of the discharge and all of the current which causes the spark, as in the action of Cavallo's apparatus and method; but that in this case the regularity of the force and steadiness of the succession of shocks is less certain because the generator is turned a certain number of times to charge the condenser, after which the discharging rod is moved toward the patient until the spark jumps to his body, the generator then being again turned and the cycle repeated. A Lane electrometer is here used only as a safeguard to sidetrack a heavy charge which might be inadvertently stored in the condenser, and to discharge it before it could do any damage.

Fig. 3 outlines the Morton method. Two Leyden jar condensers are used, the inside terminal of one being connected to the positive prime conductor of the static generator, and the inside terminal of the other connected with the negative prime conductor. Commenting on this arrangement, it is stated that the two outside terminals of the two condensers are connected together through the patient so that the secondary or induced current which surges backward and forward is the only current the patient receives. The discharge between the two inside terminals is completed through the balls of the prime conductors, the adjustable discharge rods and the spark-gap. The direct shock thus traverses the spark-gap, but it does not traverse the patient, thus differing from the arrangements of Cavallo and Duchenne. The adjustable rods constitute the Lane electrometer used for the same purpose as that Cavallo described, viz., regulating the frequency and force of every spark. As in the Cavallo's method, the static machine is operated continuously.

The conclusion of this part of the report is that in Morton's apparatus the frequency and force of the spark determine, through the medium of the condensers, the frequency and force of the pulses in the secondary circuit (which, with reference to the generator, is in shunt with the primary), while the current thereby induced is radically different in its characteristics from the inducing disruptive discharges such as Cavallo and Duchenne had utilized.

The report states that the committee has not attempted to analyze the precise physical differences between the electric current which traverses the patient under the conditions of Cavallo and Duchenne (Figs. 1 and 2), and that which is applied by the Morton arrangement of Fig. 3. It is added that statements from several eminent medical electrical authorities which appeared in several French publications, and which are quoted, indicate their opinion that the high-frequency currents which Hertz secured and described several years later, were developed by Dr. Morton and medically applied in 1880, though he did not then clearly recognize or characterize them as such. The committee considers the fact has no force that Dr. Morton did not at the time of his discovery or invention of the static induced arrangement and method fully appreciate the nature of the electric pulses which he secured or all the accompanying phenomena, or foresee all of their features of utility. The committee considers it sufficient that the devices and methods be clearly described, in the best form and mode of application which the experimenter may have worked out (so that others skilled in the same art may follow him), to entitle him to the credit of their discovery and reduction to practice, and to a claim to the foundation on which others may subsequently build structures of which he has or may have no conception.

The final conclusions are that the evidence before the committee indicates that in 1880 or thereabouts Dr. W. J. Morton devised and used an arrangement of previously existing static electrical apparatus, and in its use practised a method of producing currents, which have been widely adopted and recognized as useful in subsequent medical work; that the arrangement and method had not theretofore been known or practised, and were not evident to those skilled in the art as the result of their prior knowledge and experience, and that Dr.



FIGS. 1, 2 AND 3.—THE MORTON CURRENT.

Morton's claims of priority as made by him are entitled to the recognition of the American Electrotherapeutic Association.

We understand that the above report was rendered at the meeting of the Association this September, and its recommendations adopted unanimously; also that a committee consisting of Mr. W. J. Jenks, Dr. S. Sheldon and Dr. A. E. Kennelly, has been appointed to investigate during the year 1901-2 the physical peculiarities of the "static induced," and similar currents, which constitute the results of the experiments of Morton since 1880.

Supervision of Electrical Circuits in Cities.

In connection with the meeting in New York next week, of the Underwriters' National Electrical Association, the following remarks of Mr. William H. Merrill, Jr., electrician of the electrical bureau of the National Board of Fire Underwriters, to the *Evening Post*, are of interest: "During the last five years some 85 cities in the central western district have adopted ordinances and created efficient inspection departments for the control of the electrical hazard, as compared with less than one-half that number of cities in the East. I do not think that electrical conditions have improved in the smaller towns as rapidly as they have in the cities, and as a means to reaching these towns, I believe State supervision is necessary. There has been from time to time criticism of municipal electrical departments by persons whose knowledge of the subject has been confined to the consideration of one, or possibly two, such departments in which political influences had created discord and which for that reason were not doing all that they could for public safety. I think, however, that no one can dispute the fact that the great majority of the 125 or more municipal departments at present in operation in the United States are credits to the municipalities in which they operate, and productive of splendid results in standing between unscrupulous contractors and the lives and property of people, who are, for the most part, profoundly ignorant in electrical matters. Electrical inspection to be competent must be comprehensive, and must not confine itself to original inspections. It must inspect and inspect and reinspect. There is hardly a mercantile establishment in the United States of any size having an electrical plant which makes no changes in its electrical equipment for an interval of 60 days. These municipal electrical inspection departments—many of them—inspect the large equipments every 30 days, and in Chicago the department maintains a corps of 10 to 12 men at an annual expense of about $12,000. The work is in charge of an electrical engineer, and it has been demonstrated that as far as that city was concerned the electrical interests, the insurance interests, and the commercial interests would not permit the control of the department to remain long in the hands of any one not thoroughly conversant with electrical matters. This bars out the politician.

"Conditions which prevail at Chicago exist also in a majority of the other cities governed by electrical ordinances. I venture to say that 90 per cent of the municipal departments of the country are as efficient as the departments maintained by the insurance interests. Boston and St. Paul have notably efficient departments, and I could name 40 or 50 of the smaller cities and towns in the central western district where similar standards of efficiency prevail. Insurance interests cannot maintain comprehensive electrical inspection unless they are prepared to increase rates so as to augment revenue for the maintenance of such departments to the extent of something like a million dollars a year. This being obviously out of the question, the the remedy lies in municipal and State control.

"Where to-day we have 125 cities exercising such control, we ought to have 500. Where such departments are inaugurated it becomes more or less the duty of the insurance interests to see that they are maintained in a competent manner and that the inspections are well made and the National Electrical Code enforced. Of course, the introduction of electricity has diminished the number of fires which might have been caused by the use of other means of illumination. As people are beginning to learn that they do not need to light a house by gas and electricity both, the number of fires caused by gas pipe being burned through by electricity and the ignition of escaping gas will be further restricted.

"I do not publish as an electrical fire anything other than well established and proven electrical losses. These, of course, while they reach a majority of the electrical fires probably do not cover 25 per cent of electrical losses. I know of no way in which we can get at the facts in an account of an accurate summary of the annual electrical fire waste. Any estimates made must be merely an estimate. We know that the annual electrical fire waste is more than $3,000,000, but how much more than this we do not know, and until we discover some means of identifying the cause of a fire which no one saw start and which leaves us as its only evidence a heap of ashes, I see no way of giving a correct and definite answer to the question. Electrical equipments are in the best conditions in those territories where inspection departments have been in operation the greatest length of time. From this it follows that the East is in advance of the West in its endeavor to comprehensively control the electrical hazard."

Marconi Stations for Newfoundland.

It is announced that Mr. Marconi has sailed for St. Johns, Newfoundland, to carry out some experiments in connection with his system. During four weeks following his arrival various localities on the Newfoundland coast will be utilized in turn as stations, as one of the main points which it is hoped will be solved by his experiments is the extent of the influence natural surroundings have upon wireless telegraphic transmission. Weather conditions along this coast are notoriously bad, and electrical disturbances frequent, so Mr. Marconi will in all probability be able to study all the difficulties which at present confront the development of wireless telegraphy. As it would be tedious and expensive work to erect a huge mast at each spot selected for an experimental station, Mr. Marconi takes with him two balloons of 20,000 cubic feet capacity. These balloons will be used to suspend the aerial wire forming the shore station. With balloons it is obvious the experimenter can work with a longer aerial wire than with poles, and it is probable, weather conditions being favorable, that attempts to extend to its greatest distance the working radius of wireless telegraphy by utilizing an additional height for the wire will be made. Ordinarily the balloons will be kept about 150 ft. in the air, but may be used up to 300 ft.

The sea station will be on a steamer, equipped with a pole 120 ft. high. This steamer will work off the coast, steaming out to sea as far as communication with the shore station can be maintained. The effect of rocky shores, enclosed bays and fogs will be studied. Electrical disturbances at present form one of the most aggravating obstacles to distinct and uninterrupted communication, as when electric strays come in on the aerial wire mixed up with Morse signals it is impossible to read the tape or sounder. To discover a remedy for this defect also is one of the objects of Mr. Marconi's experiments. The steamer "Lake Champlain," of the Beaver line, which is equipped with Marconi apparatus, will be communicated with at the longest distances possible during her trips in and out of the Gulf of St. Lawrence. Mr. Marconi speaks of trying to do 250 or 300 miles, but does not promise success.

The first spot where experiments will be made is in the vicinity of St. Johns, on the northern coast lower promontory. There is already a Marconi station at Cape Race, 80 miles from St. Johns, but in order to satisfy himself on these points Mr. Marconi will move his basis of experiments from place to place between Cape Race and St. Johns, at the same time testing the difference in altitudes by comparison with the results from balloons.

An Anglo-American Building for England.

The action of an Anglo-American syndicate in applying to the London County Council for a 999 years' lease of a site on the north side of the Strand, for the erection of an office building on American lines, has caused much comment and interest. More than half the capital for the building is to come from America. Frederic B. Esler, of New York, practically promoted the whole affair. Sir Michael Farrant will be chairman of the company. Among the financial interests concerned in the project are the British Electric Traction Company and the New York & Brooklyn Tube Company. The inclusion of young Lieutenant George Cornwallis West in the directorate of the company is explained by the fact that since his marriage he has become a director of the British Electric Traction Company. He has displayed marked ability. Moreover, his wife (formerly Lady Randolph Churchill), is much interested in the office building scheme.

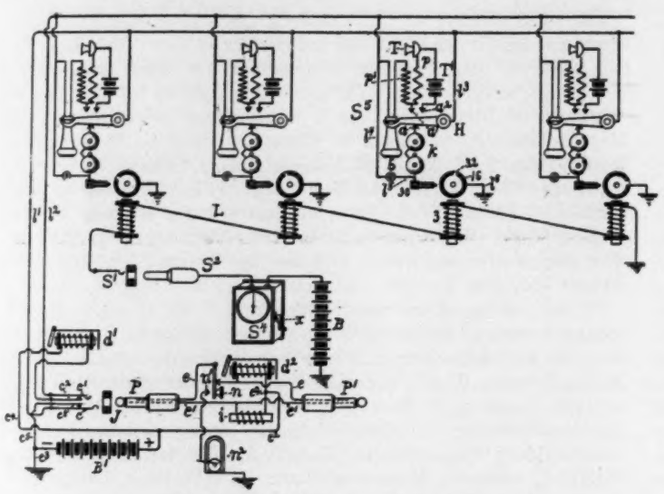
The project is discussed from various points of view. Many people share the views of William Waldorf Astor's *Pall Mall Gazette*, which throws cold water on the proposed "addition to that conglomeration of architectural chaos which is modern London." It fears that the mammoth building would deform the new thorough-

fare. The majority of the business community, however, share the views of *The Times*, which says: "We are far too slow in meeting the wants of the enormous population, and are far too much given to muddling along with timid extensions of methods essentially antiquated. The stay-at-home Englishman has a great deal to learn, and as his fine, insular superiority prevents him from learning by inspection what others are doing, the best thing possible for him is that others should come here and do things under his nose. Besides, the Americans owe us a good turn of this sort. We built many of their railroads and lost no small amount of money in the operation. It is only fair that they should energize our operations a little, though we have no desire that their experience here should be as unpleasant as that of many a British investor in wildcat lines over the water. They are really doing very well just now, setting up a magnificent electrical factory in the North, pushing the electrification of the underground roads, and interesting themselves in the 'tubes,' while American ideas and methods are largely recognized in the new telephone service."

New Telephone Patents.

Telephone patents of the issue of Nov. 19 number two only, but make up for lack of company in quantity of drawings and volume of specifications and claims. Both belong to the increasing class of inventions which aim to cheapen the use of the telephone by means of automatic devices to permit the economical use of plant and the saving of manual labor in operating.

A party-line selector system, invented by Thomas C. Drake, of Malta, Ohio, belongs to the family of party-line systems operated by selectors worked on a separate line from the telephone line proper. The system has been very thoroughly worked out, and so have others before it, but the cloven hoof of the extra line wire casts its blight on the commercial prospects of the genus. Mr. Drake provides a



PARTY-LINE SELECTOR SYSTEM.

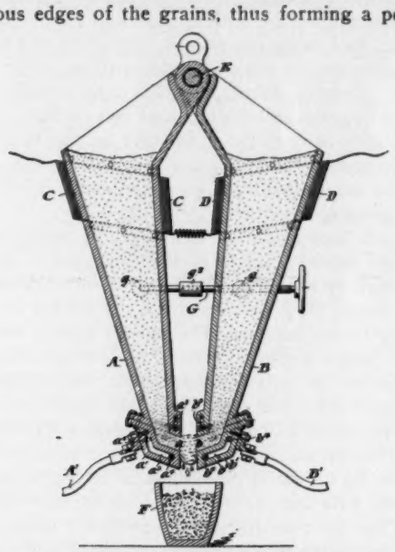
step-by-step selector designed so as to be operated for setting a contact by a "light" current, and to be released and returned to zero by a "heavy" current. The system does not provide for operation of the selectors by the stations on the line, but is operated by a central office.

In the normal state of the line the telephone circuits, both ringer and talking, are all open. A subscriber wishing to call the central office presses his push-button *b* and so closes the circuit through battery B^1, the line wires, his own bell and the line signal d^1. If no connection is already up he gets a single tap on his bell, which is normally held over by a light spring, so that a continuous current causes it to give a single stroke. When a connection is up the battery B^1 is cut out, and the subscriber on pressing his button gets no tap on his bell. He then knows that there is nothing doing, and that he must try again—or amuse himself by listening in. If the line is clear, however, he throws the line signal and the operator answers by inserting plug P^1 into the line jack *J* and pressing her listening key (not shown) in the usual manner.

To signal the station required she puts the selector plug S^2 into the selector line jack S^1 and operates the selector transmitter the required number of steps to bring the selector wheel 16 at the sub-station into contact with stop 30. This puts the bell at the sub-station to ground and the operator then inserts plug P^1 in the jack *J*, and rings the sub-station by means of ringing key *N*. The clearing-out signal d^2 shows when the called sub-station takes down and replaces his receiver, as it is energized by battery B^1 on a ground circuit which is made and broken by the closing and opening of the contact between the switch-hook *H* and the spring *A*. On receipt of the clearing-out signal the operator restores the selectors to zero by pressing a button, which throws the strong releasing current on the selector line.

Electric Furnace with Magnetic Field.

A patent has just been granted to Marcus Ruthenburg, of Philadelphia, Pa., for an electric furnace construction designed mainly for carrying into effect the inventor's method of agglomerating iron sand and similar magnetic ores, as described some two years ago. These ores, the purest source of iron at the command of the metallurgist, are exceedingly difficult of treatment, for their state of fine division not only checks the free passage through them of the furnace gases, but renders them liable to projection from the furnace by the intermittent bursting of the confined gases through the column. To agglomerate the sands into coherent but porous masses, capable of withstanding, until reduction occurs, not only the heat of the furnace but the unmeasured pressure of the supercumbent charge, is a difficult problem, and is further complicated by the necessity of avoiding, in the composition of the binding medium, any elements capable of affecting injuriously the quality of the separated metal. Mr. Ruthenburg's plan is to pass through a body of the magnetic sand an electric current of sufficient volume to weld together the contiguous edges of the grains, thus forming a porous mass of



ELECTRIC FURNACE WITH MAGNETIC FIELD.

pure ore without the use of any cementing medium or the introduction of any additional impurity.

The furnace is shown in the accompanying figure. Hoppers *A*, *B*, preferably of cast iron, pivotally suspended from a bar *E*, are provided with opposed delivery orifices *a*, *b*, the thrust-bar *G*, *g*, with an insulating section g^3, serving to bring the orifices into the desired relation. These hoppers constitute the opposed electrodes of the circuit *A' B'*, and are magnetized by coils *C*, *D*, which may be connected in series with the fusing circuit or otherwise. The delivery end of each hopper is formed of a detachable shoe *a' b'*, and means a^3, b^3, a^4, b^4, are provided for water cooling the parts adjacent to the heat zone.

The consequence of this disposition of apparatus is to constitute the hoppers and the magnetic ore contained therein the cores of opposed magnets, and the physical effect is to cause the magnetite to bridge the gap between the electrodes, there to be subjected to the maximum heating effect of the current, and to be fused or fritted, according to the temperature reached. A crucible *F* is suitably placed to receive the product. Other figures accompanying the patent show modified constructions, in which supporting devices co-operate with

the magnetic field to maintain the bridge, or in which means are provided for positively progressing the ore through the tubular magnets.

The patent affords no data regarding the strength of field necessary to maintain this bridge across the very heat zone of the furnace, nor does it discuss the question, vital as regards the practical operation of the method, of the relation between the critical temperature of the ore and the temperature at which the agglomeration occurs.

The Edison Storage Battery.

Ever since Dr. A. E. Kennelly read his admirable paper last May before the American Institute of Electrical Engineers, on the Edison iron-nickel storage battery, the keenest interest in the subject has been taken not alone by the electrical profession but by those engaged in many other fields of industrial application, notably that of automobilism. This interest has again been stimulated by the loan exhibit at the recent automobile show in Madison Square Garden of a complete cell of the battery. The cell was 12 inches high, 2 inches thick, 5 inches wide, and weighed 7½ lbs., giving 120 watt-hours, or 46 lbs. per horse-power-hour. The cell was also shown in its detail parts, and the steel plates excited much comment and surprise, being in sharp contrast to the familiar ones of lead.

The publicity given to Mr. Edison's work has led people to expect to buy the battery even now in the open market, and the disappointment expressed in many quarters is not fair to the distinguished inventor. The Kennelly paper was presented last spring against Mr. Edison's desire, but in compliance with an universal request that he would "show his hand" and tell the public what it was that he was working at in storage batteries. In the interval, Mr. Edison, who has always looked upon the Institute as the proper channel for these important communications, has maintained an absolute silence, but it would be the wildest mistake to suppose that he had also been idle. One thing can always be predicated about Mr. Edison, viz., that whether he talks or abstains from speech he is always hard at work. Indeed, although he has now reached the term of life where men of great achievement may rest on their laurels in dignified ease, it may be questioned whether he has ever followed up anything with more unrelenting zeal and enthusiasm than he has displayed in the unremitted work given to this his latest and, in some respects, his greatest invention.

Last June note was made in these pages of the formation of the Edison Storage Battery Company, with a capital of $1,000,000, and since then reference has been made to the establishment of a factory at Glen Ridge, N. J., not far from the Edison Laboratory, for the production of the battery. This means a good deal more than the superficial signs would indicate. At this present moment, the Glen Ridge factory is so far advanced that the manufacture of batteries will begin with the new year, and deliveries should come early in the spring. The inquiries and orders are such as to ensure that there will be no accumulation of the output, although provision has been made for an initial production of 100 horse-power capacity daily, although this Mr. Edison looks upon only as an entering wedge. The factory was originally a plant for the manufacture of fine jewelry, and some of its machinery is still available, but it has been thoroughly renovated and modernized, and a large amount of new machinery, tools, etc., has been put in. The main building is three stories, in addition to which there are large wings comprising machine shop, drying rooms, nickel-plating plant, etc. Dynamos, engines, boilers, etc., are already in place, and the machine shop has a fine equipment, including some special apparatus.

A mile or two away—the distance depending on which road you take—is the Edison chemical plant at Silver Lake. Here the well-known Edison-Lalande battery has been made for some years past, and now the chemical plant necessary for the new storage battery has been added. Several acres of land have also been acquired, the site being an ideal one for manufacturing uses, and the plan being to carry out here whatever extensive changes may be found necessary in the future, rather than in residential Glen Ridge, or in the crowded Edison works at Orange. Large shops have already been built at Silver Lake for the new enterprise. One of these will be devoted to the water distillation plant. Another will be devoted to the treatment of the nickel, and is already equipped with the necessary vats, etc. A third large shop is occupied by the plant for preparing the iron oxide and the graphite. All embody many novelties in construction and equipment, and show that not only has a master mind been actively employed on the various problems, but that no small amount of executive ability has been given to the task of preparation. Indeed, at the present time, the attention is incessant that is being given to the subject by Mr. Edison's staff, especially by Messrs. W. S. Mallory, W. E. Gilmore, F. R. Upton and J. M. Hill.

When interviewed on the subject last week, Mr. Edison expressed himself with the firmest conviction as to the real success he has attained in the new battery. Analyzing the cost of electric automobile operation, he pointed out that by far the largest percentage of cost lay in the element of depreciation. Under the most rigorous tests, subjected to the severest brutality that such an appliance could ever be supposed to endure in actual service, the element of depreciation, as shown by the records, appears to have dwindled to an inappreciable minimum. These tests now extend virtually over a couple of years, but are still being persisted in, with the object of determining any weakness, wherever it may lurk. As to the cost of the cell, Mr. Edison proposes to market it somewhere around the present cost of lead batteries. So far as can be ascertained, the type of cell noted above is the standard, such as would be used, for example, in automobile work. But it would appear that for stationary work far larger grids can be used; indeed, there is said to be no valid reason why they should not be 10 ft. high, or even as big as the side of a house. For separators between the plates, several successful types have been used, some of which are quite original. As a matter of fact the cell is so full of plates there is little room provided for either separators or the potash solution; but with plates so thin—one-tenth of an inch all told— the separators are naturally thin to be in keeping. The containing boxes are, as has already been noted, of steel. The weight of the solution is put at not to exceed 20 per cent of the plate weight.

The Institute Meeting and New Members.

The 150th meeting of the American Institute of Electrical Engineers was held at 12 West Thirty-first Street, New York City, Friday, Nov. 22, 1901, President Steinmetz in the chair, 200 members and guests being present. The general subject of the evening was "Methods of Distribution," upon which papers were presented by Messrs. Louis A. Ferguson, of Chicago; Henry G. Stott, of New York; Harold W. Buck, of Niagara Falls; Charles F. Scott, of Pittsburg; W. S. Barstow, of New York; W. L. R. Emmet, of Schenectady; Professor W. L. Robb, of Hartford, and Philippo Torchio, of New York. These papers are presented in abstract on page 891. The subject and papers were discussed by Messrs. Steinmetz, Dunn, Arthur Williams, Burnett, Henshaw and J. W. Lieb, Jr.

At the meeting of the board of directors in the afternoon the following associate members were elected: Cravath, James Raley, Western editor ELECTRICAL WORLD AND ENGINEER, 1139 Monadnock Block, Chicago, Ill.; Crossman, Gilbert, telephone engineer, Western Electric Company, 463 West Street, residence 80 Washington Square E., New York City; Dusenberre, George Brown, assistant to fourth vice-president Westinghouse Electric & Manufacturing Company, Pittsburg, residence Englewood Park, Pa.; Eastman, George Nial, in charge of testing laboratory, Chicago Edison Company, 139 Adams Street, Chicago, Ill.; Freudenberger, William Kaiser, chief electrician, the Colorado Fuel & Iron Company, residence 209 East Evans, Pueblo, Col.; Hamilton, Ralph Bergen, manager the Packard Electric Company, Limited, St. Catharines, Ont.; Hoopes, Maurice, mechanical engineer, J. G. White Company, 29 Broadway, residence 30 East Thirty-ninth Street, New York City; King, Harry R., electrical engineer, Western Electric Company, Chicago, Ill.; Lanphier, Robert Carr, superintendent and electrician, Sangamo Electric Company, Springfield, Ill.; Ludvigsen, Hans Valdemar, electro-chemical engineer, Blaagaardsgade 17 Copenhagen, residence Straudvejen 119, Hellerup, Denmark; Nesbit, Joseph Newton Gray, superintendent winding department Warren Electric Manufacturing Company, 416 Fulton Street, Sandusky, Ohio; O'Brien, Albert Dallam, assistant New York & New Jersey Telephone Company, 15 Dey Street, New York City, residence 151 Columbia Heights, Brooklyn, N. Y.; Pott, Arthur Henry, consulting engineer, with Preece & Cardew, residence 81 Cornwall Gardens, S. W., Queensgate, London, England; Reuterdahl, Arvid, president and chief engineer the Reuterdahl Electric Company, residence 366 Willard Avenue, Providence, R. I.; Ruchgaber, Albert Felix, draughtsman, Rapid Transit Subway Construction Company, residence 373 Carlton Avenue, Brooklyn, N. Y.; Rus-

sel, Edgar, captain Signal Corps, U. S. A. War Department, Washington, D. C.; Schildhauer, Edward, engineering department Chicago Edison Company, 139 Adams Street, Chicago, Ill.; Schmidt, Lambert, president the Lambert Schmidt Telephone Manufacturing Company, 32 Broadway, New York City, residence 138 Schippen Street, Weehawken, N. J.; Soren, Townsend Hodges, electrical engineer, General Electric Company, Schenectady, N. Y.; Tannatt, Eben Tappan, managing civil and electrical engineer the Oahu College Trustees, P. O. box 92 Honolulu, H. Ty.; Van Dyck, William Van Bergin, electrical engineer and contractor, residence 439 Manhattan Avenue, New York City; Weymouth, Thomas Rote, electrical engineer, International Hydraulic Company, 40 Wall Street, residence 80 Washington Square E., New York City; Zwietusch, Edward Otto, electrical engineer, Telephon Apparat Fabric Petsch, Zwietusch & Co., Salzufer 7, Charlottenburg, Germany.

CURRENT NEWS AND NOTES.

ENGINE BUILDERS' MEETING.—The Engine Builders' Association of the United States will hold a meeting at Sherry's, Fifth Avenue, New York City, Dec. 2-3, to be followed by dinner at the same place on Dec. 3 at 8 P. M.

UNDERWRITERS' ELECTRIC MEETING.—The annual meeting of the electrical committee of the Underwriters' National Electric Association will be held at the New York board rooms, 32 Nassau Street, beginning 10 A. M. Tuesday, Dec. 3.

MUNICIPAL ELECTRICIANS.—There will be a meeting of the executive committee of the International Association of Municipal Electricians, this week at Corning, to select and assign papers to be read at the meeting at Richmond, Va., next year.

ELECTRICITY AND CANCER.—Professor John E. Gilman, of the Hahnemann Medical College, Chicago, is responsible for a renewal of the statement that the Röntgen ray is a cure for cancer. He claims to have made successful treatment in several "incurable" cases.

THE SUBMARINE BOAT "FULTON," built by the Electric Boat Company, made a stay of 15 hours continuously under water on Nov. 23-24, at Cutchogue, L. I., with a crew and two officers of the Navy. The test which has not yet been officially reported upon, appears to have been quite successful. The submersion is said to be by far the longest on record.

MEETING OF MECHANICAL ENGINEERS.—The American Society of Mechanical Engineers will hold a meeting Dec. 3-6 at its headquarters in New York City. A number of interesting papers are listed as usual. The committee on standardization of dynamos and engines will also report. A feature will be the dedication of the memorial to Robert Fulton in Trinity Churchyard.

PRIZE FOR SUBMARINE.—A special cable dispatch from Paris says that the sexagenarian, M. Goubet, who is popularly dubbed the "father of submarines," is going to receive a prize of $20,000, given by a philanthropist, M. Osiris, for the most notable invention shown at the last Paris Exhibition. As nothing there was considered worthy, the prize was handed to the Paris Press Association, whose choice, it is expected, will fall on M. Goubet.

FISH BITE IN CABLE.—The Eastern Extension Telegraph Company has brought to notice an interesting fact in connection with the interruptions occurring in submarine telegraph cables. A fault removed a few months ago from the company's Sydney-Nelson section at as great a depth as 330 fathoms, was found to contain a tooth firmly fixed in the core of the cable, although the core was protected by the usual sheathing of thick iron wires and outer coverings. An expert examination of the tooth proved it to belong to a species of shark, the exact variety of which could not be identified; but it appears that five known varieties of sharks are found to exist at a depth of 300 fathoms, and one at a depth of even 500 fathoms.

ELECTRIC STAGES FOR NEW YORK.—Six new electric stages, each with a seating capacity of 17 persons, will be put into service this week on Fifth Avenue by the New York Electric Vehicle Transportation Company. Within another week two more will be ready, and soon there will be two "double-decker" stages, each seating 34 persons. The horse stages will continue, as at present, making trips at two-minute intervals, while the electric stages will run on a schedule of their own, ten minutes apart. As they are capable of a speed greater than that of the horses, they should be able to pass several of the old type in the course of each trip. They will make about 80 miles a day.

LONDON UNDERGROUND PLANS.—Mr. Charles T. Yerkes, in the course of an interview published in *The Daily Mail*, as he left London for New York, reveals a scheme to run a deep level express line underneath the existing Metropolitan district road. Mr. Yerkes says the contracts have been signed, and that work will be begun shortly. Commenting upon the multiplicity of locomotion schemes for London that are coming before Parliament, *The Times* says: "There is danger of repeating the mistake made above ground and of allowing things to be done piecemeal, instead of subordinating all to a general plan. A careful study of the experience of New York would be of immense benefit to the metropolis. The Americans have thrown away a good many expensive plants and are now embarking upon larger enterprises than ever; and consequently they are an exceedingly useful people to study."

TRACTION CONCESSION IN CHINA.—Mr. Conger, the United States Minister in Pekin, has protested, it is reported, against a concession which the Canton Viceroy has granted to a French company for an electric railway from Canton to Wu-Chau, on the ground that it violates Wu Ting Fang's contracts with the American syndicate, which has the concession for the Canton-Hankow line. The French Minister is pressing China to ratify the concession, arguing that the American contract has been forfeited by the sale of a controlling share of the original stock to the Belgians. The question is further complicated by the fact that Sheng has contracted with a German firm to supply cash and materials to the value of $1,000,000 for the construction of the Ping-Hsiang Branch Line, which also is contrary to the terms of the Washington contract. Mr. Conger is awaiting instructions from Washington on this point.

USE OF MOLDING MACHINERY.—At the recent meeting of the National Founders' Association in New York City, on the question whether the molding machine, for a complicated class of machinery, was a profitable investment, Mr. G. E. Emmons, of the General Electric Company, of Schenectady, opened the debate by stating that after considerable reluctance he adopted the molding machine, not meeting with success until he obtained a trained operator of the machines to supervise their operation. Since then, he said, their adoption has been most successful. Intricate and comparatively large castings are being turned out on the machines now, and, while upward of 60 of them are now in use at the Schenectady shops, the number is constantly being increased. He produced figures showing the adoption of the machines to be a very profitable investment. Mr. Emmons stated that his experience showed that the molders on certain difficult work were obtaining better results than did the laborers first employed.

ANTI-HUNTING DAMPER.—The employment of eddy current circuits in connection with alternating-current machines is not a new development, but recently they have come into prominence in various forms as anti-hunting devices. As far back as 1892 an eddy-current circuit was employed on a type of Stanley motor, in this case consisting of copper bars sunk flush in the stator and at each end connected to a copper ring. Similar to this is a well-known squirrel-cage "amortisseur" of Maurice Leblanc. Within the past few years several special forms of dampening devices have been described, principally in connection with rotary converters. One of these consists of a copper bridge between the poles, another of a copper ring surrounding the poles, and the third of a copper sheathing covering entirely or partially the pole face and extending over the edges. A patent issued Nov. 19 to A. D. Lunt describes still another form, which consists of a copper case or sheathing applied only to the pole tips. The sheathing or tip case is fashioned to fit neatly about the tip and is secured thereto by a bolt at each end.

RUBBER IN VENEZUELA is the subject of a most interesting report in the Consular Bulletins of the State Department from Consul Goldschmidt, of La Guayra. It embodies a description of the caoutchouc of the Upper Orinoco by Dr. Lucien Morisse, who says that 50,000 emigrants could easily be employed in the forests gathering the gum, and cutting the trees, without any injury to the permanence of the supply.

TRANSMISSION IN CALIFORNIA.—Before the close of November, the Standard Electric Company, of California, expects to complete its high-tension line into the Eighth Street sub-station in San Francisco. When this is completed there will be ready for disposal in San Francisco electrical energy developed on the Yuba River and conveyed via the lines of the two great transmission companies, the Bay Counties Power Company and the Standard Electric Company, a distance of 222 miles.

A CURTAIN ROD TIES UP THE BOSTON ELEVATED.—A curious accident occurred in Boston a few days ago, resulting, it is stated, in considerable damage to the electrical equipment of the Boston Elevated Railway. A woman, evidently on a shopping tour, was carrying home a couple of brass curtain rods, one of which dropped on the track at the Sullivan Square terminal. It fell across the third rail and one of the traction rails, and short circuited the system. Considerable insulation was destroyed and traffic was interrupted for some time.

A HIGH-SPEED ROAD FOR CHICAGO.—The Aurora, Elgin & Chicago Railway, now being built, will employ a third rail weighing 100 lbs. per yard. This road is to give a high-speed service between Chicago, Aurora and Elgin by way of Wheaton. The track is being laid with a view of maintaining a maximum speed of 70 miles an hour on the level, and the motor equipments which have been ordered are designed for that speed. The General Electric train control system is to be used on the cars, and there are to be four 125-hp motors on each car.

ELECTIONEERING BY PHONOGRAPH.—It is stated that a candidate for municipal honors in Sheffield, England, has latley been putting his views before the electors by means of a phonograph. At a recent Parliamentary election in Victoria, one of the candidates shirked the task of personally airing his views by sending a phonograph around the various townships in charge of a man on horseback. The electors, however, resented the application of this time-saving method, and left the owner of the machine at the bottom of the poll. The main difficulty seems to lie in the fact that, while the phonograph will render a speech plainly enough, it cannot be heckled or made to reply to questions.

TALKING TO MARS.—In a recent lecture in Philadelphia, Sir Robert Ball is reported to have utterly discredited any idea of "talking with Mars." Sir Robert estimated that to signal Mars so as to be seen by a Martian astronomer who happened to be looking this way, using the wigwag system, we should need a flag 300 miles long and 200 miles wide, waved from a staff 500 miles long. Flashlight signaling he considers equally impracticable. If Lake Superior could be filled with petroleum and set on fire, the resulting blaze might be discerned as a speck of light, but not sufficiently prominent to suggest that anything unusual was in progress. He does not appear to have considered electrical means worthy of discussion.

REGULATION OF ALTERNATING CIRCUITS.—A patent issued Nov. 19 to A. R. Everest describes a means for regulating the voltage of an alternating-current circuit, whereby with a constant generator voltage the voltage of the distributing circuit may be kept constant at all loads, or may increase with increase of load, in the latter case corresponding to the effect of over-compounding at a generator. In the simplest form an inductance is used in one leg of the circuit to be regulated, and another beyond the first in shunt across the circuit. The first-mentioned inductance is designed so that its core is saturated throughout the full range of the load, while the shunt inductance has its coil so proportioned that its core remains unsaturated during normal operation. In other applications of the principle a compensator is connected across the distributing circuit, and one end of the generator circuit connected to an intermediate point of the compensating coil. In still a third application a condenser is added in shunt to the saturated inductance, a compensator being also used.

CONDENSER SINGLE-PHASE MOTOR.—In most single-phase motor starting devices the torque is a minimum at starting, but with increasing speed is increased by the addition of the torque produced by the armature reaction of the motor, which finally preponderates. For purposes of comparison it is, therefore, desirable to compare motor-starting devices only with respect to the torque which they produce at the moment of starting. In a patent granted Nov. 19 to Charles P. Steinmetz it is stated that when a phase displacement for starting is produced through the agency of self-induction in series with a main or mains, he has found it impossible in the cases of a motor with a quarter-phase winding to obtain a symmetrical quarter-pahse system for starting, without which the starting torque is not as large as would otherwise be the case. He has discovered, however, that by the use of a condenser or a device possessing effective capacity, the impressing circuits of the starting device may be so adjusted as to produce e. m. f.'s equal in value to each other and displaced in phase by 90 degs., thereby securing a marked increase in starting torque. As illustrated applied to a single-phase squirrel-cage motor as a quarter-phase starting device, a condenser is connected at one side to the middle point of the field winding and at the other side to a "compensator" across the mains. The compensator appears to be a choke coil, and it is stated that it may be replaced by the secondary winding of a transformer.

LETTERS TO THE EDITORS.

Modified Three-Wire System.

To the Editors of Electrical World and Engineer:

Sirs.—In your issue of Aug. 3 I notice a paragraph on a modified three-wire system patented July 23, consisting of two compound generators used in the ordinary way on two sides of a three-wire system, and a third, or more, double-voltage machine used between the two outers, all the machines being compounded and the outer brushes connected by an equalizing wire.

For my firm I have installed a plant on exactly the same lines, which was running in November, 1900. It was originally a simple two-wire system, with two compound machines, their brushes being connected by an equalizing wire. It was then decided to increase the plant, and, acting as engineer for the Boulder City Council and for my firm, I had it changed to a three-wire system, and added on a third machine at 440 volts, and used this machine with the equalizing wires in the manner stated. The plant has worked successfully ever since, the regulation being excellent.

I do not know of any other plant in this country run in this fashion, and I have never heard of any before. All the machines and engines were supplied by the B. F. Sturtevant Company, of Boston, and have given every satisfaction.

PERTH, WEST AUSTRALIA. L. J. B. WALL.

Electrical Engineering in England.

To the Editors of Electrical World and Engineer:

Sirs.—I was not a little surprised to see an article in a recent Export Issue of your paper by Mr. E. Kilburn Scott regarding the conditions of electrical factories in Great Britain and the incompetence of electrical engineers in general. The article is one which, considering Mr. Scott's own position and his own education in the business, had better never have been written by him. And any criticism of this nature would have come better from other pens. As a matter of fact, Mr. Scott is quite wrong in many of his statements, and in conversation is quite willing to admit that many of the electrical factories in Great Britain are first rate in every particular.

Your correspondent, during the two years which he has been in Great Britain, has visited personally a great many of the factories of electrical manufacturers in Great Britain, and he is quite prepared to

state that they compare extremely favorably with factories either in the United States or on the Continent. There could not possibly be a better factory than that of the English Electrical Manufacturing Company and the factories of the Electric Construction Company, Thomas Parker, Limited, Ferranti, the Brush Electrical Engineering Company, Bruce Peebles & Co., Newton Electrical Works, and Electro-Motors, Limited, and a number of others leave almost nothing to be desired for the amount of business which they are doing. It is quite true that some of the older companies have plants which are to a certain extent obsolete, but many of them are making arrangements for new factories, or are already building them, and within the next year or two there will be in Great Britain some of the best electrical factories that it would be possible to see anywhere.

LONDON, ENGLAND. A. C. SHAW.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Induction Motors with Phase Compensation for High-Speed Railroads.—HEYLAND.—He refers to Reichel's description of the induction motor of Siemens & Halske for the experimental high-speed railroad (ELECTRICAL WORLD AND ENGINEER, Nov. 2). It was required that the motor should start at three times the normal load. This is accomplished by switching the motor from the normal e. m. f. of 1150 volts over to 1850 volts. At the same time the power factor decreases from 0.9 to 0.75. He shows that it is an inherent disadvantage of the ordinary induction motor that it cannot be designed in such a way that it works with uniform efficiency for wide variations of load. Favorable conditions for one load mean unfavorable conditions for another load. He says that his induction motor "with phase compensation" (Digest, Aug. 31, also ELECTRICAL WORLD AND ENGINEER, Sept. 28, page 492), could be used for such purposes to good advantage. One might say that the power factor does not become unity, before the motor has approximately attained its speed. This is true, but it is possible to design the motor so that its maximum power factor without compensation is obtained for that overload at which it is to start. What the value of the power factor would be at normal operation, is of no account, as then the compensation of the phase difference renders the power factor equal to unity. Such a motor would have very favorable dimensions—a strong field, few windings, shallow slots, low straying, and an excellent power factor when starting with overload. The available space can be made use of to obtain the best efficiency and the least heating, one does not have to take into account the power factor. The compensating device can be restricted to a small space, and is best connected directly to the transformer. After it has been put in its place no more attention or regulation is required. There is no switching over after starting; the motor starts with a power factor equal to 0.9, which then goes over to unity. Another great advantage is the electric braking, which is just as simple as for the direct-current motor. The ordinary induction motor as used in the Siemens & Halske high-speed railroad car requires two processes of switching, and a storage battery besides. With the compensated induction motor, however, it is only necessary to switch the primary leads to a rheostat, exactly as with a direct-current shunt-wound motor. He gives the following comparison of the ordinary induction motor and his compensated motor: When started at three times the normal load, the ordinary motor has a power factor 0.75 and requires one process of switching, his compensated motor starts with a power factor 0.9 and requires no switching. At full load the ordinary motor has a power factor 0.9, his compensated motor a power factor equal to unity. When running below full load, the ordinary motor has a power factor smaller than 0.9, his motor has a power factor equal to unity. The no-load current is 50 amperes for the ordinary motor and 3 amperes for his motor. The efficiency is 95 per cent for both motors. Breaking requires two processes of switching and a storage battery with the ordinary motor, and a single process of switching without battery with his motor. Hence his compensated motor only betters the conditions and does not deteriorate them in any way. He promises a further article, "When the results of the tests of the experimental motors will have been collected."—*Elek. Zeit.*, Nov. 7.

Rotary Converters vs. Motor Generators.—H. S. MEYER.—An article criticizing some statements in the article in ELECTRICAL WORLD AND ENGINEER, Sept. 21, page 460, in which motor-generators of both the synchronous and the induction types made by the Oerlikon Company were compared with rotary converters and the necessary step-down transformers of some other make. He says that the comparison of machines of entirely different makes does not lead to satisfactory figures. In the case of motor-generator sets, the figures given for the efficiency are taken from curves, obtained either by calculation or tests, while the figures for the rotary converter are values guaranteed by some American manufacturer. As it is common practice in the United States to allow, in all guarantees concerning electrical constants of a machine, a safe margin of ½ to 1 per cent under the value obtained in actual test, the comparison should be corrected from this point of view. If this is done, a decided advantage appears on the side of the rotary converter. It should furthermore be borne in mind that the motor-generator sets seem to be built on special order, while the rotaries and transformers quoted are of standard make. The comparison of heating constants also shows inconsistency, as values obtained from actual tests after a full-load run of 10 hours, are compared with guaranteed limits, which can only refer to tests of a much severer character, corresponding to the standard American heating guarantees for this class of machine. Regarding weight, the advantage is also in favor of the rotary converter, and he gives figures to show that the same is the case regarding cost. He estimates that for a 300-kw plant, a saving of $2,400 to $3,300 is in capital outlay effected by the choice of rotary converters instead of motor-generators. Finally, regarding the floor space required, the rotary converter is again preferable, as the transformers can be located either in the basement or on an elevation in the sub-station, leaving only the rotaries to be placed on easily accessible ground. With the motor-generator proposition, more than double the actual floor space is required for the two machines. Other favorable points of the rotary converter are the large overload capacity and the easy method of compounding on the alternating-current side by phase control. He agrees, however, that in certain cases the motor-generator is to be preferred. He concludes that both classes of machines have their field, but wherever possible, from the requirements of the system, a rotary converter should be given the preference as being cheaper, more efficient, and taking less floor space. In an editorial note it is said that to make Meyer's statement regarding costs conclusive, it would be necessary to work out the yearly sum required for attendance in each case. In actual practice the type of machine used will often be decided on the unquestioned merit of simplicity of working in the cases of the motor-generator, or small floor space required in the case of rotary converter.—Lond. *Elec.*, Nov. 1.

Calculation of Polyphase Generators.—PICHELMAYER.—An illustrated article on the determination of the armature stray field. This is difficult to calculate, but can be determined with sufficient exactness by means of experiments with actual machines, the results of which can be used later for the calculation of similar machines. He gives a simple formula, containing a coefficient, which he has determined for various types. The values of this coefficient, thus determined by experiment, are given in a table. Another method for determining the stray field is as follows: If the magnet system is removed and the stator winding is supplied with the supply current, the e. m. f. required for driving the supply current through the winding, is very nearly equal to the e. m. f. of straying. This experiment must be made with the same frequency as that intended to be used with that machine.—*Elek. Zeit.*, Oct. 31.

REFERENCE.

Coupling.—An illustrated description of the Zodel elastic and insulating coupling by means of which the dynamos are connected to the turbines in the power stations of the Jungfrau Railroad.—*L'Ind. Elec.*, Oct. 25.

POWER.

REFERENCES.

Mechanical Applications of Electricity.—RICHARD.—An article giving illustrated descriptions, taken from patent specifications, of several new inventions—the Hopkinson drill, the Liebert electromagnetic control of machine tools, the Weyland-Smith system of automatic regulation of rolling mills, the Quimby electric pump, the Thomson-Houston automatic valve for electric pumps, and the Hewlett automatic regulator for compressed air canalizations.—*L'Eclairage Elec.*, Oct. 12.

Snoqualmie Transmission.—An illustrated article on "Æsthetics in and extensions of the Snoqualmie transmission," especially a description of the new sub-station of the Seattle Cataract Company and the Tacoma Cataract Company.—*Jour. of Elec.*, Oct.

TRACTION.

REFERENCES.

High-Speed Electric Railways.—CARUS-WILSON.—The first part of an illustrated article on the experiments made by the German Association for the Study of Electrical High-Speed Railways, and on the two experimental cars built by this association, which have been fully described in ELECTRICAL WORLD AND ENGINEER. In some editorial notes it is said that apparently the electrical and mechanical difficulties attending the construction of the car have been so successfully overcome that failure to attain a speed of 120 miles an hour need hardly be apprehended, and that the really serious difficulties will probably be found in the track.—Lond. *Elec.*, Nov. 1.

St. Louis.—A long illustrated description of the new power stations of the St. Louis Transit Company. After the street railway companies of St. Louis were consolidated, two new modern power plants were built which replace 11 old stations, four of which were cable power houses. There is also one rotary converter sub-station where three-phase currents are changed into direct current. The article is well illustrated by diagrams.—*St. R'y Rev.*, Nov.

Contact Device for Feeding Automobiles from Overhead Wires.—REYVAL.—An illustrated description of the Vedovelli contact device by which automobiles are supplied with current from two overhead wires. It is a small carriage running on the two overhead wires as rails.—*L'Eclairage Elec.*, Oct. 12.

Automobile.—GASNIER.—An article in which he calls attention to the fact that in a competitive test, arranged by a French automobile journal in 1899 and 1900, it was found that in the present automobiles about one-half of the power generated by the motors is lost in the gearing. It is, therefore, of importance to have exact methods of measuring the power available at the wheels of an automobile. He describes at some length the method used for this purpose in the contest mentioned above, and a new improved method.—*L'Ind. Elec.*, Oct. 25.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Electric Switches.—KENNELLY.—An abstract of a lecture given at Sibley College, Cornell. The character of an installation is clearly indicated by the form of switching devices used. Among the most interesting forms of switch are the very satisfactory modern oil immersed switches for extremely high-tension service. A noticeable feature of all of the modern switches for opening high-tension circuits is their extreme simplicity, the main endeavor being to obtain a long break, with safety to surrounding apparatus and to the attendants. The switches for manipulating circuits of large current-carrying capacity at moderate pressures are much more complicated in mechanism on account of the massiveness of the parts and of the mechanical force necessary to operate them. There is a peculiar danger in the handling of large alternating currents, especially in the opening of heavy overloads or short circuits. The energy stored in the medium about the circuit is one-half the inductance multiplied by the square of the current, and this energy must be dissipated while the switch is being opened. If the operator happens to open the switch when the current is passing through zero, no trouble can result. But if the circuit is broken when the current is at or near maximum, its potential energy is very great. The only possible disposition of this energy after the circuit is open, is in the electrostatic form with the result that in circuits of large inductance and small capacity the pressures generated may be dangerously high, amounting to many times the normal circuit pressure. This effect must be distinguished from that known as resonance in which the reactance due to inductance and capacity balance at a certain frequency, and hence give rise to great local pressures.—*Sibley Jour.*, Nov.

REFERENCES.

Trafford Park.—The first part of an illustrated article on the supply of electric power, light and fuel gas in Trafford Park, Manchester. Direct-current generators, assisted by motor-driven balancers, supply the local area by means of a three-wire network with 500 volts between the outers. To areas further away, three-phase currents will be transmitted, which will then be changed to low-tension direct current by means of motor-generators. The generating plant at present in use consists of two sets, each of 1000 horse-power.—Lond. *Elec. Rev.*, Nov. 1.

Narragansett.—A long and well illustrated description of the Narragansett Elec. Lighting Co.'s system, which furnishes light and motive power for half of the State of Rhode Island.—*Elec. Rev.*, Nov. 9.

German Plant.—WINAWER.—An illustrated description of the plant supplying current to Niederbronn and Reichshofen, two small German towns at a distance of a mile from each other. The three-wire direct-current system, with 440 volts between the outers, is used. Two thousand incandescent lamps of 16 to 25 candles, 30 arc lamps, and some motors of together 30 horse-power, are supplied from a steam-driven dynamo.—*Zeit. f. Elek.*, Oct. 20.

Mill Installation.—BENTOM.—An illustrated description of the electric installation of a cellulose plant and a paper mill in Cosel, Germany. The three-wire direct-current system, with 220 volts between the outers, is used for lighting, direct current at 220 volts for traction, while three-phase currents are used for transmission.—*L'Eclairage Elec.*, Oct. 26.

Combined Lighting and Traction Switchboard.—An illustrated description of the Ferranti switchboard for a combined 460-volt lighting and 500-volt traction system.—Lond. *Elec.*, Nov. 8.

WIRES, WIRING AND CONDUITS.

Wiring Rules.—WORDINGHAM.—He distinguishes between wiring rules and supply rules. Wiring rules properly deal with the details of the devices employed to utilize a supply of electrical energy, with the means adopted to control the supply to such devices and with the provision, fixing and protection of the conductors for distributing the energy within the premises, to which the supply is given. He discusses the question of wiring rules and supply rules under the present legal conditions in Great Britain. Central station engineers should make and enforce such regulations as are necessary to ensure a satisfactory supply of energy to all classes of consumers, they should give their active support to the carrying out of essential rules as to the wiring of their consumers' premises as laid down by the (Brit.) Inst. Elec. Eng., and should rigorously abstain from interfering in petty non-essential details. The same issue contains two letters by Jeckel and Wilmshurst, on wiring regulations.—Lond. *Elec.*, Nov. 8.

REFERENCES.

Calculating Polyphase Circuits.—An article giving formulas for calculating the sizes of wires for two-phase and three-phase circuits.—*Jour. of Elec.*, Oct.

Conduits.—SULLIVAN.—An article on interior conduit construction and the national electrical code.—*Elec. Rev.*, Nov. 16.

ELECTRO-PHYSICS AND MAGNETISM.

Electron Idea.—KAUFMANN.—A lecture on the development of the electron idea. The modern theory of electrical and allied optical phenomena, which may be summarized under the name of the electron theory, means practically a return to views as laid down in the sixties and seventies by Weber and Zoellner, but modified by the results of Maxwell's and Hertz's researches. The various theoretical and experimental researches which have led to the electron theory, are briefly summarized in a review which is quite interesting, but cannot be abstracted. As is well known, the theory supposes the existence of negatively charged "electrons" of a mass of about one two-thousandth of the mass of an atom of hydrogen, while the positive charge is always associated with the more massive atom, as a whole. This view completely obviates an objection which was formerly used to disprove the ionic theory of gaseous conduction. It had been asked, how it could be possible for a monatomic gas, say, mercury, to dissociate itself into ions. The answer is: Not into electrolytic

ions, but into a positively charged atom and a negative electron; both together form the neutral monatomic molecule. The paper is discussed in an editorial at the end of which the practical usefulness of the electron theory is discussed. To prove that the electron theory may have practical utility, the following argument is given. "Since the discovery of the electron has been made independently of Röntgen's discovery of his famous rays, it is conceivable that the fully enunciated electron idea might have been published before Röntgen made his discovery. In that case it would have been possible to have predicted the Röntgen rays, to have predetermined their properties, and subsequently to have constructed apparatus for their manufacture for any practical purpose."—Lond. *Elec.*, Nov. 8.

Tesla's Artificial Lightning.—H. J. RYAN.—A reproduction of a photograph of Tesla, sitting in his laboratory amidst a shower of electrical discharges. "It is said that the length of the path that these sparks traversed is about 70 ft. It is well-known that at high pressures approximately 15,000 volts are required to break down each inch of air at common temperatures and pressures. This amounts to 180,000 volts to the foot. From this we see that the pressure required to produce a 70-ft. spark must be about 12,600,000 volts." The use of such high pressures for wireless telegraphy and transmission of waves in general is pointed out. Tesla's ambition is said to be to work out a "reliable method for the efficient and continuous development of high-pressure, high-frequency currents, after which he would in due course expect to work out a system for the long-distance transmission of power, using the universal atmosphere as the medium of propagation of the electrical energy by the transmission of such energy either as dielectric flux or magnetic flux—details to be decided upon after a satisfactory source of high-pressure high-frequency current has been povided."—*Sibley Jour.*, Nov.

Thermoelectric Force and Electric Resistance.—HARRISON.—An abstract of a Brit. Phys. Soc. paper on the variation with temperature of the thermoelectric force and of the electric resistance of nickel, iron and copper, between the temperatures of —200 degs. and + 1050 degs. The curves for variation of the thermo e. m. f.'s with the temperature of copper-nickel and coper-iron couples are roughly a straight line and a parabola respectively. The electric resistance of nickel increases with the temperature almost parabolically up to 370 degs., when a change of slope occurs and the resistance increases much less rapidly and almost linearly up to 1050 degs. In the case of iron the resistance curve does not change its parabolic form till nearly 800 degs., when it becomes linear and remains so up to 1050 degs. He concludes that the thermoelectric change in nickel-copper coincides approximately with the resistance change, but that no thermoelectric peculiarity exists for iron-copper at the temperature of the iron resistance change.—Lond. *Elec.*, Nov. 1.

Susceptibility of Ferric Chloride.—MOSLER.—An account of an investigation of the temperature coefficient of the magnetic susceptibility of ferric chloride with varying concentration. A 10-per-cent solution has a temperature coefficient of 0.00268, at 28 per cent there is a sudden increase, and at 33 per cent a maximum of 0.00358 is attained. The original value is regained at a concentration of 41 per cent.—*Ann. der Phys.*, No. 9; abstracted in Lond. *Elec.*, Oct. 25.

Magnetic Induction in Crystals.—WALLCRANT.—The permeability of crystals depends upon their position in the magnetic field. It may happen, as in the case of pyrrhotine, that a crystal is entirely non-magnetic when the direction of the field coincides with the ternary axis of the crystal, though the same crystal will show decided magnetization in other positions. The present author shows that this behavior can well be represented by mathematical formulas.—*Comptes Rendus*, Oct. 21; abstracted in Lond. *Elec.*, Nov. 8.

Magnetization and Modulus of Elasticity.—TANGL.—An account of an investigation of the relation between longitudinal elasticity and magnetization. If a wire is magnetized under constant tension it changes its length. If it is magnetized in such a manner that its length remains constant, the tension varies. The ratio between the two alterations is proportional to the modulus of elasticity under the magnetization applied. This is the principle on which his measurements are based. The results go to show that magnetization increases the modulus.—*Ann. der Physik*, No. 9; abstracted in Lond. *Elec.*, Oct. 25.

REFERENCES.

Electric Waves.—ABRAHAM.—A discussion of the theory of the propagation of electric waves along wires. He distinguishes two cases, in the first of which the return current is a pure conduction current, and in the second, displacement currents also come into action. He discusses the relation between the conditions of propagation and the electromagnetic energy of the waves.—*Ann. der Phys.*, No. 10; abstracted in Lond. *Elec.*, Nov. 8.

Dielectric Strain.—MORE.—A note on dielectric strain, in which he replies to the criticism of Sacerdote, noticed before in the Digest.—*Phil. Mag.*, Nov.

Point Discharges.—TAMM.—An investigation of the manner in which the amount of electricity discharged by a point maintained at a certain potential, depends upon the moisture and pressure of the surrounding air.—*Ann. der Physik*, No. 10; abstracted in Lond. *Elec.*, Oct. 25.

Fluoroscope.—CALDWELL.—An illustrated article on a new method of obtaining stereoscopic effects in the fluoroscope.—*Elec. Rev.*, Nov. 16.

Bismuth.—LOWNDS.—An account of an investigation of "the thermomagnetic and thermoelectric properties of crystalline bismuth." He studied the longitudinal and transversal thermomagnetic phenomena and the thermoelectric force with relation to copper.—*Phil. Mag.*, Oct.

Magnetic Induction.—BUCHANAN.—A brief "contribution to the theory of magnetic induction in iron and other metals." It is a continuation of a former paper, in which he gave a general theory. He now applies the theory to some of Ewing's experimental results. The curves for annealed iron and for hardened iron are subjected to harmonic analysis.—*Phil. Mag.*, Nov.

Terrestrial Magnetism.—The October issue contains a German paper by Ebert, on the distribution of the electric ions in the higher layers of the atmosphere; an illustrated description of the Lloyd-Creak dip circle for observations at sea; several reports by Kesslitz, Moureaux, Haga, Snellen and van Rijckevorsel on the magnetic observations made during the total solar eclipse of May 17, 18, 1901, in several observatories in Austria, France and Holland; also a biographical sketch with portrait of Professor von Bezold.—*Terr. Mag.*, Oct.

ELECTRO-CHEMISTRY AND BATTERIES.

Dielectric Constants of Pure Solvents.—SCHLUNDT.—Nernst and Thomson have deduced the rule that, other things being equal, the greater the dielectric constant of a medium, the greater is its dissociating power. The present author had made an extended study of the dielectric constants of pure solvents. A number of new examples have been found which follow the Nernst-Thomsen rule, but also some striking exceptions which show that the rule is inadequate. The exceptions indicate that the nature of the solvent, as well as the dissolved substance, are of prime importance in determining whether a solvent will conduct electricity. Other results of the investigation are: The value of the dielectric constants for the homologous series of compounds examined, decrease with increase of molecular weight. The introduction of the cyanogen group in a compound causes a marked increase in the value of the dielectric constant. In this respect the cyanogen radical produces a greater effect than all other radicals which have hitherto been systematically studied.—*Jour. Phys. Chem.*, Oct.

REFERENCES.

Increasing the Capacity of Accumulators.—HEIM.—An illustrated translation in abstract of his German paper on the influence of temperature on the capacity of accumulators which was noticed recently in the Digest.—Lond. *Elec.*, Nov. 1.

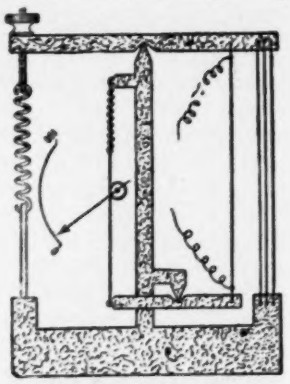
Influence of Electrical Waves on Chemical Action.—LENGFELD and RANSOM.—A brief note on some preliminary experiments in which they studied the influence of electrical waves of 300 meters length upon chemical action. The results so far showed no influence.—*Jour. Phys. Chem.*, Oct.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Absolute Measurement of Self-Inductance.—DUANE.—A description of a method of measuring the absolute value of the self-induction of a coil without using a standard of self-induction or of capacity. Suppose the coil is wound in two parts. If the current flows in the same direction through both coils in series the self-inductance of the whole, which may be called *I*, is the sum of the self-inductances of the two coils plus twice the mutual inductance. If the current flows in opposite directions through both coils in series, the self-inductance of the whole, which may be called *II*, is the sum of

the self-inductances of the two coils minus twice the mutual inductance. In the first part of the method the ratio of *I* and *II* is measured by comparing each with a third self-inductance. In the second part of the method the value of the mutual inductance is measured, which can be done by any of the usual methods (for example, with the earth inductor and ballistic galvanometer or the doubly wound solenoid and ballistic galvanometer method). The difference of *I* and *II* is four times the mutual inductance. As the ratio and difference between *I* and *II* are known, *I* and *II* can be calculated directly. In order to use this method it is necessary to be able to break the circuit of the coil at some point inside of it. This can be done best during the winding. He suggests that all coils that are to be used as standards of self-inductance, be wound in two sections. It is not desirable to break the coil in such a way that he mutual inductance is small; on the other hand, it is not desirable to break the coil in the middle. The best method of winding lies between these two. If the coil to be measured is not wound so as to be broken conveniently, its self-inductance can be measured by means of the above method, slightly modified, by joining the self-inductance to be measured in series with another self-inductance coil of the same order of magnitude, and placing the two coils near together so that the mutual inductance has a certain value. The self-inductance of the total combination, considered as one circuit, is measured, and also the ratio of the two coils. The two coils must, of course, retain their relative position during the entire measurement, otherwise the mutual inductance would vary. (In some cases it might suffice to wind a temporary coil over the one to be measured and removing it again after the measurement.—Comp.)—*Phys. Rev.*, Oct.

Hot-Wire Instruments.—SOULIER.—An illustrated description of hot-wire voltmeters and ammeters, devised by Chauvin and Arnoux. The special feature of the instruments is the method used for compensating for the variation due to temperature changes and for increasing the deviations of the needle. Several wires of the same material and cross-section as the wire heated by the current to be measurd, are fixed at one end to the frame of the instrument, and are connected at the other end to the one terminal of a lever, pivoted on its center. These wires are shown at the left hand of the adjoining figure and are not in circuit. They are tightened by the action of the spiral spring, shown at the right hand of the figure. Parallel to the bundle of insulated wires there is the real "hot wire," connected at one end to the lever mentioned before, and at the other end to another lever which is in connection with the device for increasing the deviation of the needle. It will be seen that when the temperature of the air rises, the bundle of insulated wires compensates for this temperature error of the hot wire. The device for increasing the deviation of the needle acts as follows: When the hot wire varies its length due to the heating of the current, the lowe lever, one arm of which is connected to the hot wire, is acted upon, the other arm is connected to a fixed point of the frame by means of a thread and spiral string. A point of this thread is fixed to a cylinder of small radius and revolvable around its axis. When the lever is acted upon, the cylinder is turned and the needle, connected with this cylinder is deflected. It can be shown that his arrangement is very sensitive. The hot wire used can stand three times the normal current without any other inconvenience except that the zero point of the instrument is changed, but it can easily be restored by means of a screw. Voltmeters and ammeters of this type are described.—*L'Ind. Elec.*, Oct. 25.



HOT-WIRE INSTRUMENT.

Direct-Current Meter for Small Currents.—An illustrated description of the Hookham meter for small currents. The 5-ampere size starts at 0.05 ampere. The instrument resembles in some respects a Perry meter. Its armature is in the form of an inverted cylindrical cup, which rotates in an intense permanent magnetic field, and to which contact is made by means of mercury. The cup rotates on a vertical spindle. No extra brake is provided, as the cup, rotating in a strong magnetic field, is itself an eddy-current brake. This braking action is proportional to the speed of rotation, but the fluid friction is also to be reckoned with, which is proportional to the square of the speed. The friction is, therefore, too great at high speeds, and to compensate for this, an electromagnet is provided, through which the main current passes on its way to the armature of the meter. The action of this coil is to weaken the field in which the armature rotates and to reduce the brake force relatively to the driving force, as the current and speed increase, so to compensate for the slow error at high loads which would otherwise result from fluid friction of the mercury. This object is attained by diverting part of the field of the permanent magnet from the main path.—Lond. *Elec.*, Nov. 8.

Alternating-Current Terminology.—BOUCHEROT.—A communication referring to the recent suggestions, made by the editor of that journal, as noticed in the Digest, Nov. 2 (see also ELECTRICAL WORLD AND ENGINEER, Nov. 16, page 805). He believes the term "magnetizing power" would be better than "fictive power," and "magnetizing current" better than "current in quadrature." His argument is that the term suggested by him would give at once a definite idea of the action of the component of the current in quadrature, as in the great majority of apparatus used in practice, it produces a magnetic field and magnetizes the apparatus. The case of the current in quadrature, absorbed by a condenser, is only an exceptional one, of small importance.—*L'Ind. Elec.*, Oct. 25.

TELEGRAPHY. TELEPHONY AND SIGNALS.

REFERENCES.

Wireless Telegraphy.—TURPAIN.—Illustrated descriptions, taken from British patent specifications of several new inventions: Oscillator and coherer of Armstrong and Orling; coherers of Brown; coherers of Marechal, Michel and Dervin; coherer, relay and decoherer of the Am. Wireless Tel. Co., with operation by compressed air; an arrangement of Ferrie to use the coherer in ordinary telegraphy over wires; rather complicated wireless telegraphy apparatus of Cervera Baviera; and a relay of Guarini Foresio.—*L'Eclairage Elec.*, Oct. 19.

Automatic Telephone Exchange.—An illustrated article on the automatic telephone exchange at Fall River, Mass.—*Elec. Rev.*, Nov. 16.

MISCELLANEOUS.

United States and Great Britain.—An article on "American competition as it really is." British manufacturers are recommended to follow Americans in an improvement of methods of manufacture, better arrangement of machine tools, the use of machines capable of doing work more rapidly, and the adoption of modern systems of gauge working; but they should not drop the commendable quality of durability. "American work will often be very well designed, and surprising results will be obtained from small amounts of material, but durability is not a prominent feature." American "wares are perhaps mechanically good, they look well, are made perhaps promptly to time, but they do not possess the quality of durability." "Now, are our engineers going to learn order and method, and good shop practice, before the Americans learn liberal design, and the secret of durability?" "The success of American competition has caused a very severe epidemic of swollen head among the Americans, and they have presented the ridiculous picture of a nation behind a 50 per cent wall of tariffs, shouting that they can whip the world. Yet Americans consider themselves a humorous people."—Lond. *Elec. Rev.*, Nov. 8.

REFERENCES.

German Manufacturing Plant.—An illustrated description of the plants of the Union Electric Co. and of Loewe & Co.—Lond. *Elec.*, Nov. 1.

Manufacturing Plant.—An illustrated description of the works of the Stanley Electric Manufacturing Co. at Pittsfield.—*Elec. Rev.*, Nov. 2.

Glasgow Exhibition.—An illustrated description of exhibits of the British Schuckert Co. on electrically-driven double-acting duplex plunger pump, an electrically-driven winch, an overhead traveling crane, a high-pressure switch, electric drills, and several exhibits relating to electric traction.—Lond. *Elec. Rev.*, Nov. 1.

British Manufacturing Plant.—An illustrated description of the works of "Electromotors, Limited," in Manchester.—Lond. *Elec. Rev.*, Oct. 25.

German Manufacturing Plant.—A continuation of the serial on the recent visit of the Brit. Inst. Elec. Eng. to Germany, giving a well illustrated description of the plant of Lahmeyer & Co.—Lond. *Elec.*, Oct. 4.

Storage Battery Manufacturing Plant.—MARMOR.—An illustrated article on the plant of the Storage Battery Company, of Hagen, Germany.—*Cosmos*, Oct. 5.

Electrical Engineering in Europe.—ALDERSON.—An illustrated article on technical high schools in Germany and Switzerland.—*West. Elec.*, Oct. 26.

New Books.

MILL BUILDING CONSTRUCTION. By H. G. Tyrrell. New York: The Engineering News Publishing Company. 40 pages, 46 illustrations. Price, $1.

While this little volume contains but 40 pages, the information it gives is in such condensed form that it appears to cover the entire subject of mill building construction, so far as relates to practical details and data. The first chapter is on loads, under which are treated roof, floor and crane loads, snow and wind loads, and miscellaneous loads. Very full data of weights are given, including a table of weights of various kinds of merchandise load. The second chapter is on general design, the sub-heads being walls and roof trusses, spacing of trusses, jack rafters, roof coverings, truss connections, rafters, bottom chords, purlins, stress factor, lighting and ventilation and the estimation of cost. In the latter section is a table of prices which enable the approximate cost of a building to be quickly estimated. The third chapter is on "Design and Structural Details," with the following sub-heads: Foundations and anchorage, concrete floors, asphalt floors, wood floors and car shed floors—all of these referring to ground floor construction. Upper floor construction is treated under the heads of steel trough floors, corrugated iron and bridge arch floors, steel girder and timber floors, and slow-burning wood floors. Roofings are treated under the heads of slate roofing, asphalt roofing, slag and gravel roofing, corrugated iron roofing, sheet steel roofing, crimped and steel roll roofing, tin and terne plate roofing, rubber and asbestos roofing and wood and metal shingle roofing. A table is given of the comparative cost of the above roof coverings.

The final section is on miscellaneous structural details, including wall anchorages of roof trusses, doors and windows, ventillators and gutters and down-spouts. Throughout the book are scattered working drawings of details, and under each section are given complete data as to weights, dimensions and area, loads and useful tables of cost.

THE INDUCTION MOTOR. By B. A. Behrend. New York: Electrical World and Engineer. 105 pages, 56 illustrations. Price, $1.50.

This volume, containing 105 octavo pages, is devoted to a simple, graphical treatment of the elements of design and characteristic performance of the polyphase and single-phase induction motors, and of the general alternating-current transformer. The author says in his perface: "I have made the induction motor the subject of early and special studies, and a comparison of my treatment of its theory with the purely mathematical theories will show how far I have succeeded in simplifying and elucidating so complex a subject."

The book is written from the designer's point of view. Such point of view in this instance is based upon a considerable knowledge of the physical characteristic existence and performance of the induction motor. That is to say, the author derives his treatment of the induction motor from a close study of its actual performance as modified by design changes. The treatment amounts to but little more than a statement, in which graphical methods are largely employed, of the nature of the results of actual trial and study of the fundamental phenomena of behavior of the induction motor.

The reader who hitherto has made some considerable study of the induction motor as usually treated in our language will find this work of great interest on account of the distinctly different and more composite and, therefore, simpler mode of treatment herein employed. Though the modes of treatment are beautifully simple, the author evidently throughout expects that the reader is already familiar with the physical and practical properties of the induction motor. For this reason the reader who is just beginning his studies of the induction motor should first read S. P. Thompson's "Polyphase Electric Currents and Alternating-Current Motors."

The opening chapter gives a graphical treatment of the General Alternating Current Tansformer. This is followed by a chapter on the Character of the Magnetic Field in the Polyphase Motor. The form dimensions and magnetic and electric proportions here taken up have reference to the real model of the induction motor as it actually exists. The next two chapters define the *short circuit* and *leakage factors* as the chief factors upon which the actual characteristic behavior of the induction motor depends. Three chapters are then given up to the calculations for the design and predetermination of the performance of a 200-hp, three-phase motor and a 180-hp single-phase motor. The final chapter of the book is on the Polar Diagrams of the General Alternating-Current Tansformer. Three appendices include a reprint of Kapp's excellent statement of the working properties of the induction motor and some useful graphical methods.

This book is altogether out of the common run of books in that it gives distinctly and only what the author himself has produced. While some reference is made to those who originated the component methods employed, yet the treatment, as a whole, is decidedly original with the author, so that the purchaser of this book will in nowise be securing a repetition in phraseology of what has been said by many others on the induction motor.

BOOKS RECEIVED.

HOW TO BUILD A 3-HP LAUNCH ENGINE. With a Full Set of Working Drawings and Explanatory Text. By E. W. Roberts, M. E. Cincinnati, Ohio: The Gas Engine Publishing Company. 66 pages, illustrated. Price, $2.50.

LINEAR DRAWING AND LETTERING. Accompanied by a blank book for lettering. By J. C. L. Fish. Palo Alto, Calif.: J. C. L. Fish. 65 pages, 46 illustrations. Price, $1.25.

COMPRESSED AIR. Its Production, Uses and Applications. By Gardner D. Hiscox, M. E. New York: Norman W. Henley & Co. 322 pages, 40 tables and 545 illustrations. Price, $5.

LES APPLICATIONS PRATIQUES DES ONDES ELECTRIQUES. By Albert Turpain. Paris: C. N. Naud. 412 pages, 271 illustrations. Price, 12 francs.

OUTLINES OF ELECTRO-CHEMISTRY. By Harry C. Jones. New York: Electrical Review Publishing Company. 106 pages, 13 illustrations. Price, $1.50.

PRACTICAL X-RAY WORK. By Frank T. Addyman, B. Sc. (Lond.). ELECTRIQUE. By Henry Martin. Paris: Ch. Beranger. 760 pages, 870 illustrations. Price, 25 francs.

CONGRES INTERNATIONALE D'ELECTRICITE. Rapports et Proces-Verbaux. By M. E. Hospitalier, Rapporteur General. Paris: Gauthier-Villars. 526 pages, illustrated. Price, 20 francs.

SCHALPUNGSARTEN UND BETRIEBSVORSCHRIFTEN. By Alfred Kistner. Berlin: Julius Springer. 210 pages, 81 illustrations. Price, 4 marks.

THE ELEMENTS OF ALTERNATING CURRENTS. By W. S. Franklin and R. B. Williamson. Second Edition, rewritten and enlarged. New York: The Macmillan Company. 333 pages, 238 illustrations. Price, $1.75.

Motor-Driven Tools.

The general economical advantages of the electric motor for driving machine tools have become so fully recognized that one can safely predict that it is a matter of comparatively few years when all large machine shops will be electrically driven. In addition to the advantages arising from superior economy in distribution of power, and in freedom from a maze of belting, with consequent reduction of shop expense and better utilization of space—which advantages alone suffice to establish the superiority of the electric over the belt drive—for certain work and classes of tools the electric motor is peculiarly adapted as a source of power. Indeed, its use promises to work a revolution in at least one department of machine shop practice, for in certain heavy work it has been found that instead of bringing the work to the machine, the latter when motor driven may with much greater advantage be transported to the work. To illustrate some of these particular advantages of the electric motor as applied to machine tools, we print herewith several views of electrically-equipped tools, for which we are indebted to the Westinghouse Electric & Manufacturing Company.

Fig. 1 shows a large portable tool operated by an induction motor, which, as will be seen, is enclosed in the base. The disproportion

between the size of the motor and the tool which it operates is quite striking, as is also the fact that a tool of this enormous size should be a portable one. This is one of a number of new tools in the new

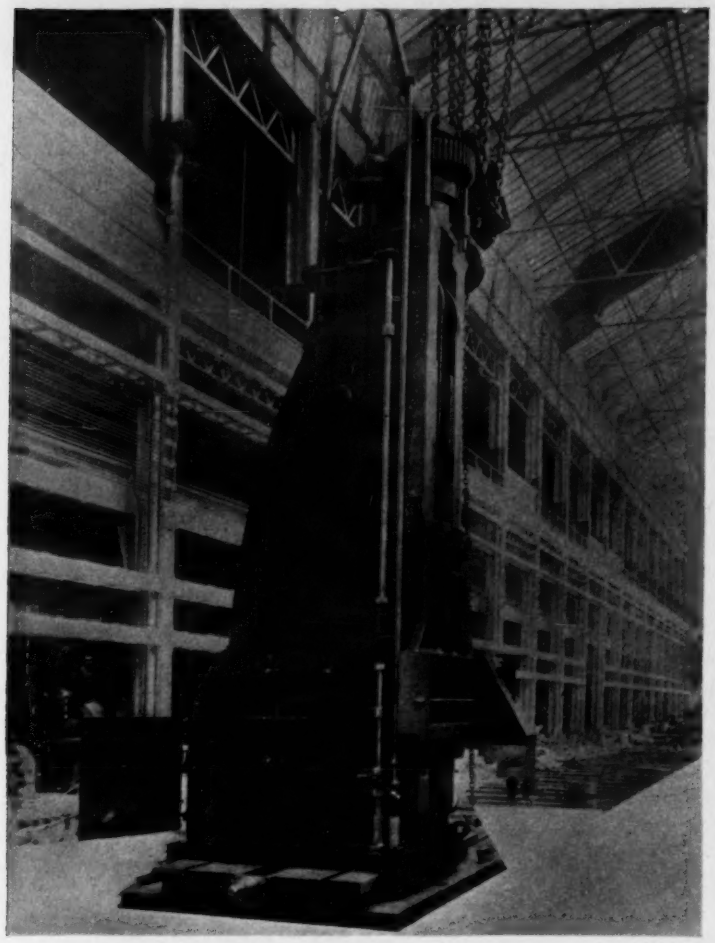


FIG. 1.—LARGE PORTABLE TOOL.

bay of the Westinghouse works at East Pittsburg. A great area of the floor of this bay consists of bed plates to which work may be

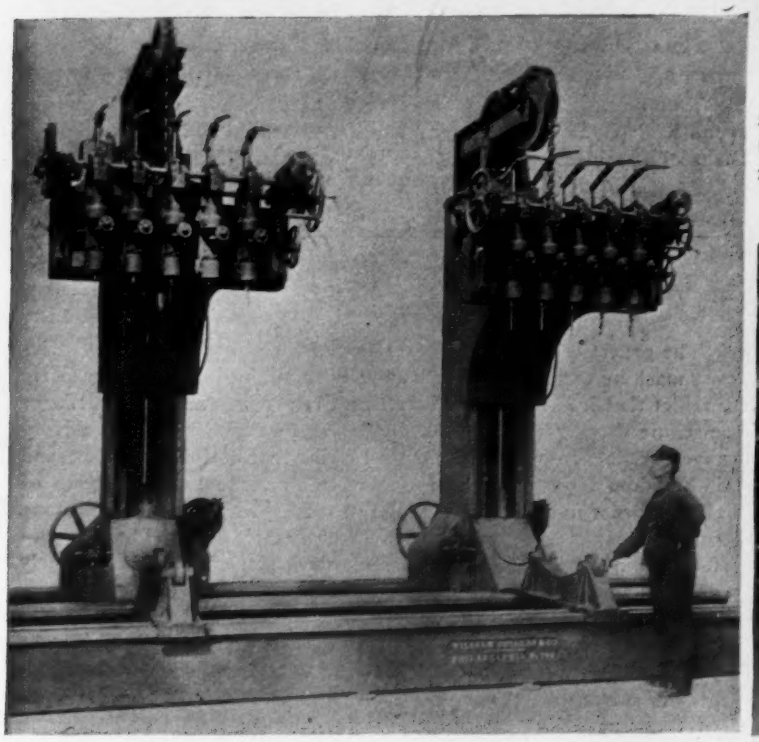


FIG. 2.—BOILER PLATE DRILLING MACHINE.

fastened in the most convenient situation, the tool required being then moved to the work.

Fig. 2 shows a ten-spindle boiler plate drilling machine, and Fig. 3 a double-slotting machine for locomotive side frames, both of which illustrate the advantages of the electric motor in the case of tools having movable power elements. The simplicity of the arrangement

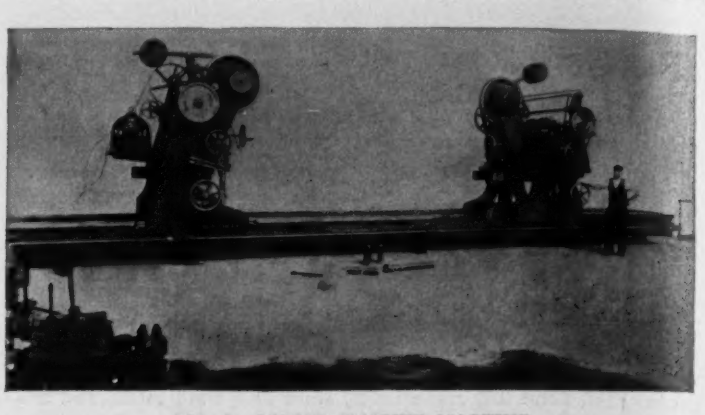


FIG. 3.—DOUBLE SLOTTING MACHINE.

with motors is in notable contrast to that which would be necessitated were the tools belt driven.

In Fig. 4 is shown a boring mill driven by an induction motor, and having a variable-speed gear attachment. In this case the motor and the entire change gear is enabled to be placed beneath the floor level. The 28-ft. boring mill of Fig. 5 is driven in this manner from

FIG. 4.—BORING MILL.

a covered-over pit, and in addition there is a small motor mounted on the top frame to furnish power for raising and lowering the immense cross-head.

Fig. 6, showing the end of a 122-inch lathe, illustrates admirably

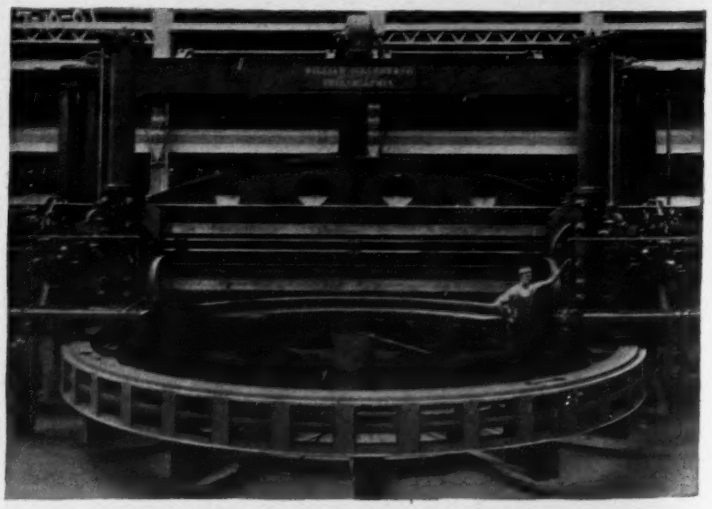


FIG. 5.—28-FOOT BORING MACHINE.

the simplicity with which an electric motor may be applied to a machine tool, and the small amount of space which it occupies, even in a machine of the power of this lathe. This is also illustrated in Fig.

7, which shows a 14-spindle drilling and boring machine for working on water-tube boilers.

As an inspection of the cuts will show, some of the tools illustrated

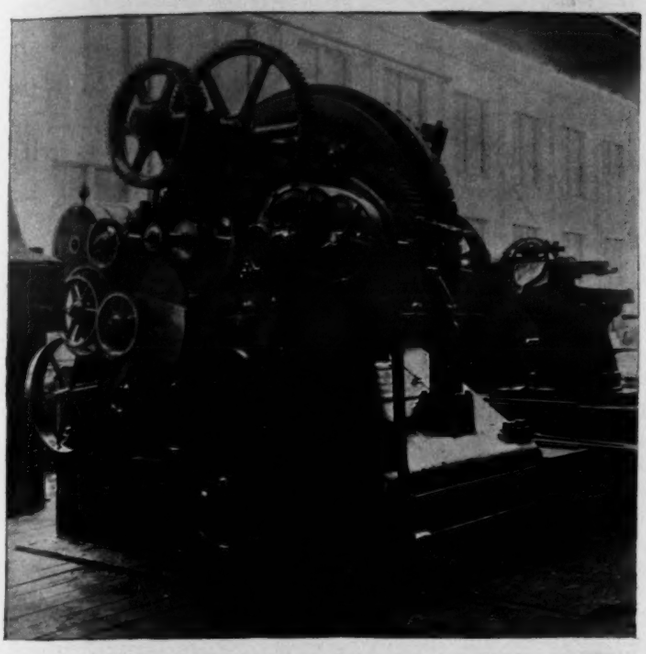


FIG. 6.—122-INCH LATHE.

are driven by induction motors and others by direct-current motors, the kind employed in any case depending, not on the type of the

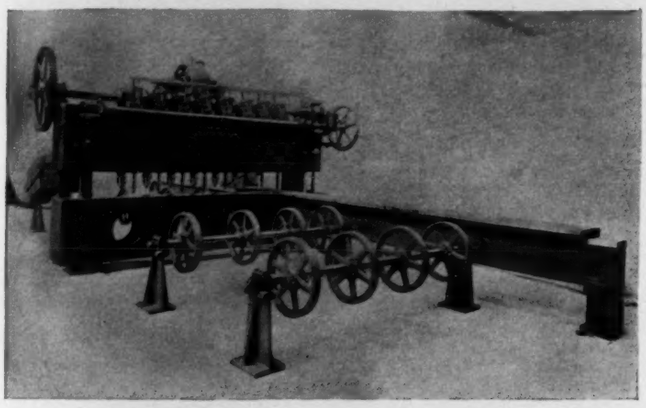


FIG. 7.—SPINDLE DRILLING AND BORING MACHINE.

motor, but on the character of the source of power. All of the machines illustrated are driven by Westinghouse motors.

Bullock Railway Generators.

The accompanying illustrations show a 1000-kw Bullock railway generator, and some details of both engine and belt-driven types of the railway machines manufactured by the Bullock Company.

The frames of these machines are divided horizontally, and are eliptical in section with pole seats projecting sufficiently to allow of machining to provide for a perfect magnetic point between yoke and pole. The pole pieces are from thin annealed sheet steel having high magnetic permeability. The form somewhat resembles a letter "T" having one-half of the upper line cut away. They are assembled with each alternate sheet turned so that the formation of the pole is a perfect "T," but owing to its peculiar form, the pole is slotted to a depth of about ½ inch across its entire face. The effect of this is a more perfect distribution of magnetism in the air-gap resulting in a fixed point of commutation and sparkless operation at all loads.

The shunt and series coils are separately wound. The shunt coil is in each case wound upon a built spool of press and fuller boards. After winding the exterior of the spool and coil is covered over with cotton tape and the coil finished by an exterior winding of "Sampson" cord which is varnished with shellac, thus giving to the finished coil a handsome appearance. The series coil is of copper strip insulated with cotton and similarly treated. By winding the coils separately, better radiation is secured, and the ample carrying capacity and good ventilation guarantee a low temperature under constant load.

The armature coils are all bar wound, i. e., copper strip is forced into a cast iron mould of the proper form for the coil, the coil consisting of two or more convolutions, according to requirements. After being thus formed each convolution of the coil is wrapped throughout

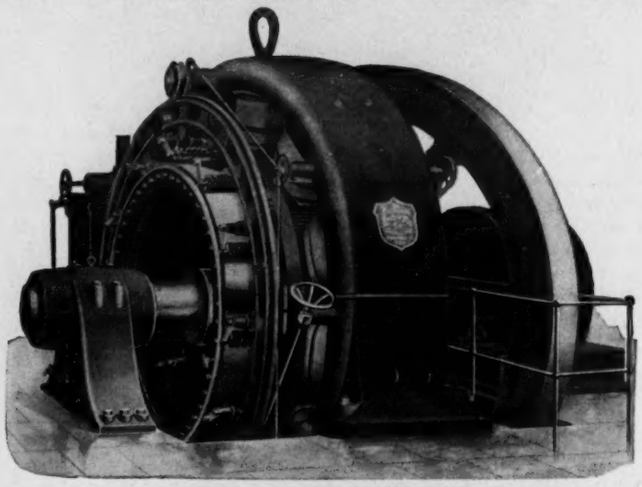


FIG. 1.—1000-KW ENGINE TYPE RAILWAY GENERATOR.

with cotton tape. The several convolutions are then grouped and the ends or exterior portions are again wrapped with tape, forming the unit winding. After being thus far completed, the coils are dipped in insulating varnish and placed in the drying oven. When the drying process is complete the active portion of the coil or that part embedded in the armature core, is covered with several thicknesses of red rope paper, "Empire" paper, India mica, and an outside covering of "Fish" paper, each layer being treated with shellac. The coil is then put into a steam heated press and assumes a rectangular form of the exact dimensions of the core slot. It remains in the press under heat until all surplus insulating varnish and shellac has been driven out, and while still under pressure the coil is cooled. Fig. 2 shows a partly wound coil of a 250-kw belt-driven generator.

The commutator bars are standardized, thus facilitating repairs when necessary. The mica used is of a special quality, and in service

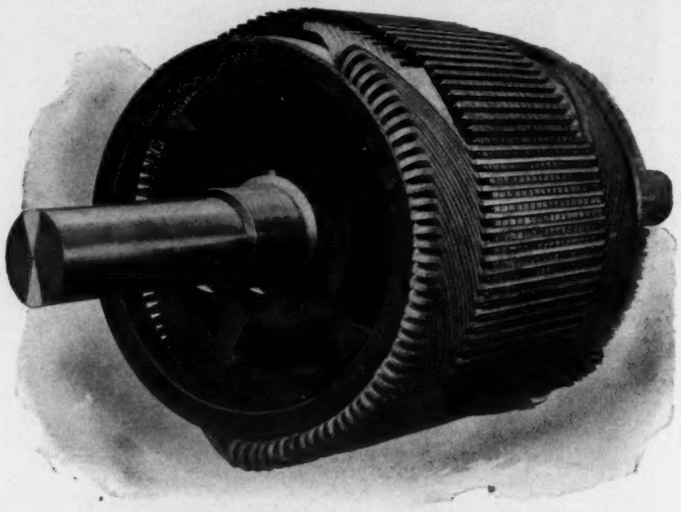


FIG. 2.—PARTLY WOUND ARMATURE OF 200-KW GENERATOR.

wears uniformly with the copper and adds materially to the life of the same. The bars are well insulated from the shell. Ample brush service has been provided to care for current to be carried and brush friction without undue heating.

The armature core is built from laminations of thin sheet steel mounted upon a spider of cast iron. The ends of the arms are of a dovetail formation, carefully machined for an exact fit, and engage slots on the inner periphery of the core. The slots for the

windings have parallel sides with grooves near the top into which the coil retaining wedges are driven. These wedges obviate the use of band wires, and protect the coil from mechanical injury. Thus should a bearing run hot and melt out, the windings would not be injured by contact with the poles. No band wires are used.

The brush holder (Fig. 3) is very simple in design, and of the reaction type. A dovetail groove is cut in its face, in which a projecting screw head from the brush engages. This prevents the

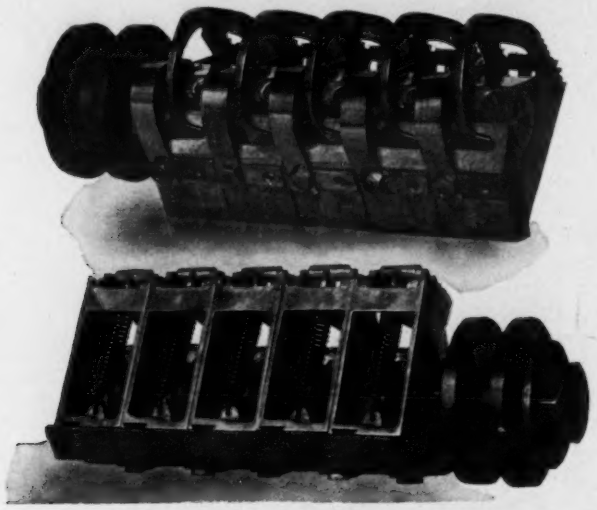


FIG. 3.—FRONT AND BACK OF BRUSH HOLDER.

brush from jarring out or swinging away from the holder when the tension finger is raised. Carbon brushes of rectangular section and beveled ends for tangential contact are used. Flexible leads connect the brushes with the holder furnishing a direct path for the current.

A heavy cast iron ring is mounted upon three trunions supported by the yoke (Fig. 4). Internally projecting arms carry the brush studs. Brush studs of like polarity are connected to copper cross connectors, mounted between the yoke and brush ring. These connectors are wound with "Sampson" cord and connected by leads to the terminal board. On engine type machines of 200 kilowatts and above, there is a brush shifting mechanism for shifting the brushes latterly. This movement is very similar to the end play in belted machines, and obviates any tendency of the brushes to groove or cut the commutator.

The design of these machines permits a large air-gap. Operation, however, is not seriously interfered with, even with quite a large dis-

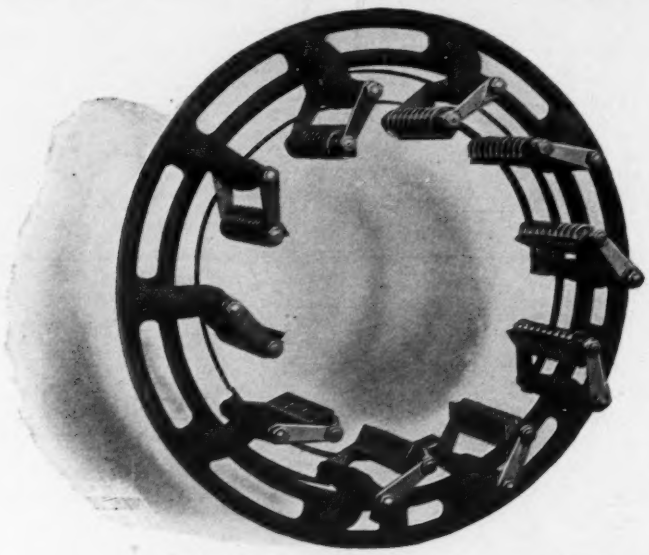


FIG. 4.—BRUSH HOLDER YOKE.

placement of the armature, and no material change in the magnetic pull on the armature occurs with such displacement. The generators will run perfectly in multiple with other similar machines. They are so designed that they will take proportion of the load under all variations. Great care is taken to have the mechanical and electrical balance of the machines perfect. The standard for insultion is based upon the specifications adopted by the American Institute of Electrical Engineers.

The Regulation of Electric Light.

A practical device for regulating the light of an incandescent lamp which may be simply applied to an ordinary fixture has long been needed, and the Sayles electric light regulator, shown herewith, appears to satisfy the want. By its use, the light of an incandescent lamp may be graded through five stages, the light at the lowest stage being even less than can be safely furnished by turning down a gas jet, and corresponding to that given forth by a small oil night lamp. That is to say, it places the incandescent lamp as to light control practically on a parity with the gas jet.

It is a somewhat singular fact that the saving over normal consumption when a light is reduced below normal by means of resistance, is sometimes contested, and even by electricians who should know better. The misunderstanding, however, has probably been due to considering only the matter of watts per candle-power, instead of viewing the question from the meter, and, therefore, the consumers', standpoint. Without means of regulating a lamp, the consumer either continues to use a lamp at its full candle-power, though he may desire less light, or he turns it off when he should otherwise be quite willing to have it in circuit at a lower candle-power. In the first case he pays the price of 50 watts for a larger amount of light than he may require, whereas by the insertion of resistance he could procure the actual amount of light he desires at the cost, say, of 25 watts. It is true that the watts per candle-power would be greater in the case of the reduced light owing to the loss in the resistance, but the consumer is only concerned with the cost of burning the lamp as he desires and as is registered by the meter, and not with a technical question of efficiency per unit of light.

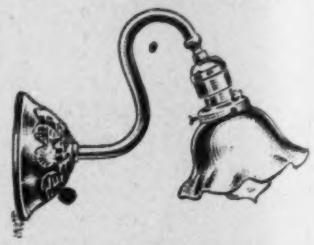
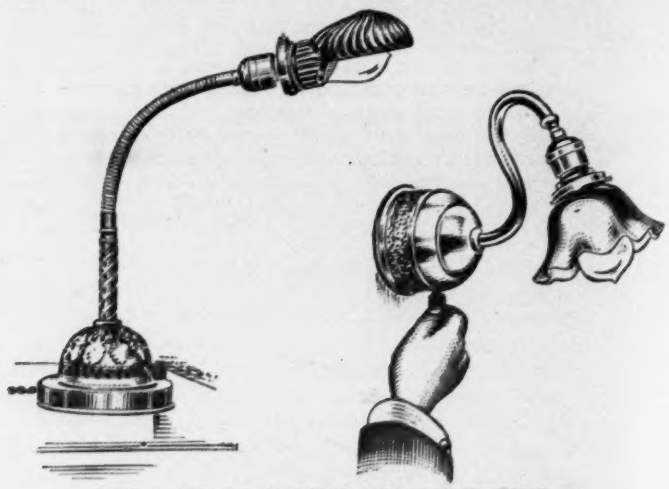


FIG. 1.—OVER OUTLET BOX.

In other words, the only choice offered him is to burn a light at normal candle-power or, say, 50 watts, or at a smaller candle-power with less watts per lamp and, therefore, at less cost than for normal light, even though at a greater rate of energy consumption on the unit or watt-per-candle-power basis. We have assumed that the misunderstanding has been due to considering only the matter of watts per candle-power, for the slightest consideration of Ohm's law in its form watts = current × voltage, makes it evident that, with the voltage constant and current reduced below normal by resistance, the watts per lamp will be reduced in proportion to the current.

Notice of the device illustrated appeared in these columns at the time of the issue of the patent upon which it is based. Since that time the details of manufacture have been carefully worked out by Mr. J. E. Sayles, manager of the Electric Regulator Company, 136 Liberty Street, New York, formerly general agent of the Edison



FIGS. 2 AND 3.—PORTABLE AND CANOPY TYPES.

Electric Illuminating Company, of New York, and later identified with the electric heating business. A delay of several months was caused by a somewhat protracted illness of Mr. Sayles, but there have been now placed on the market several forms of this regulating device, which has been approved by the Underwriters and by the New York Department of Public Buildings, Lighting and Supplies. It has also been tested and indorsed by the New York Edison Company, with a certificate that it affords an "actual saving at the meter"

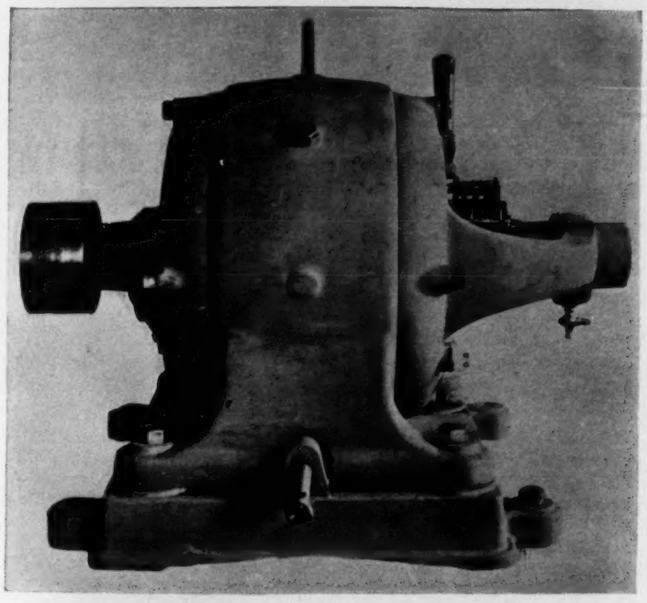
of about one-third to three-fourths "as the volume of light is reduced."

We give herewith illustrations of three of the forms manufactured, consisting of a complete portable lamp ready for connection, and of two canopy types which can be applied to any fixture. One of the latter is adapted to use where no outlet box is installed, in which case the regulating device, which consists of a switch, resistance tube and base, all covered by a canopy, is fastened to the wall by feet stradling the crow-foot; the other has the feet mounted on the outlet box, but in both cases the device passes over the insulating joint and is perfectly insulated and securely held in place. It is governed by a key projecting from the canopy, or in the case of the portable, from the base.

The device, which embodies a cast-iron enameled resistance tube of ingenious construction, is practically indestructible, and operates to control the light in the most efficient and satisfactory manner. The especial point is made that the device only requires the use of the usual commercial lamp as supplied by all lighting and supply companies, and does not require that special lamps shall be purchased by the consumer. In the case of a 50-watt lamp, the consumption at reduced candle-power is about 33, 25, 18 and 12½ watts, respectively, corresponding to the several switch points. The device is applicable both to direct and alternating-current circuits.

Reliance Dynamo and Motor.

We illustrate herewith a type of dynamo and motor made by the Reliance Electric Company, of Milwaukee, Wis. As will be seen, the frame is made of one solid circular piece of cast steel, the bottom of which is shaped to form the feet. There are four-pole pieces, oval in form, with shoes cast solid on the same, and so shaped as to hold the field coils firmly in place. The pole pieces are accurately fitted



DYNAMO AND MOTOR.

to the frame in a manner to insure the best magnetic contact and the greatest stability.

The heads are of cast iron and reversible. They are fitted to the frame with a perfectly tight machine joint, and held securely in place by tap bolts screwed into lugs on the frame. The bearings are of gun-metal, and of generous dimensions, with large oil pockets and "ring oilers" insuring cool running. The shaft is ground and polished to a perfect gauge at the bearings.

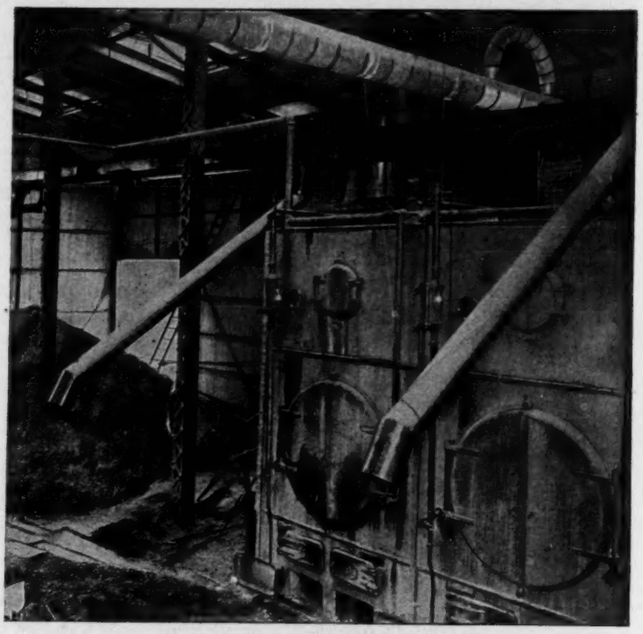
The armature core is made up of thin steel disks, insulated from each other, and assembled under a heavy pressure upon a cast iron spider. The disks are separated at intervals with a plate which forms a series of vertical ducts through which a constant flow of air is forced when the armature is in motion.

The armature coils are all form wound, and each coil is insulated to withstand a breakdown test of 2000-volt alternating current. The system of winding is such that a positive circulation of air is maintained through the coils and end winding while the machine is in operation. After the coils are inserted in the slots of the armature disks and before being connected to the commutator, a further insulation test is applied.

The field coils are also form wound, and, as in the case of the armature coils, are interchangeable. They are slipped over the pole pieces before bolting the same to the frame, and are easily removed or replaced. The commutator bars are held securely in place by wedge-shaped steel rings and ring nuts threaded to the shell and perfectly insulated with India mica. The commutator is assembled under a heavy pressure and braking process. The brush holder is of brass, and employs carbon brushes.

Coal Handling Machinery for a Small Plant.

The cut herewith illustrates a coal-distributing plant designed and erected by the Aultman Company, of Canton, Ohio, for the Lewis Bergdoll Brewing Company, of Philadelphia, Pa. This steam plant has 12 boilers, fired by hand, with anthracite pea coal. A side track runs parallel with the end of the boiler room. Coal is received in bottom dump cars and dumped into a hopper beneath the track. From the bottom of the hopper a chute controlled by an automatic discharge gate leads the coal to a bucket elevator located just inside the end wall. This elevator discharges into a 12-inch steel screw conveyor 65 ft. long, operating in a steel trough (as shown in the illustration), placed on the columns of the building 19 ft. above the boiler room floor. The front of each boiler is served with coal through discharge gates and spouts placed at proper intervals in the bottom of the conveyor trough; these discharge gates being operated from the floor level. The capacity of the system is 30 tons of coal per hour from car to boiler room. A 6-hp electric motor furnishing



COAL-HANDLING APPARATUS.

the requisite power to operate it. The approximate cost of the entire apparatus erected in place is less than $1,000.

A reserve storage of coal for several days' consumption is stored under cover in the vacant space next to the elevator, which can be allowed to flow back into the elevator booth for distribution by the screw conveyor in the same manner as coal direct from the cars would be distributed. Where gondola cars are used the track hopper is replaced by a shoveling hopper into which the coal is shoveled from the cars, a chute leading from this hopper into the elevator.

In a steam plant of the size illustrated, eliminating the advantages of storing several days' coal supply under cover, and the saving in time effected, a conservative estimate of the direct money saved by the use of a coal-handling plant is said to be not less than $400 per year, after allowing a liberal percentage for interest, maintenance, depreciation and power cost to operate it, a sum of sufficient magnitude to make its installation an object to owners of steam plants.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Call money closed at 4 per cent, nominal; time money was freely offered, closing at 4½ per cent for 60 days to six months on high grade collateral, and 4½@5 per cent on good mixed collateral. The stock market showed a very strong and advancing tendency, owing to the fact that further expected heavy gold exports did not take place at the end of the week, and on various favorable reports regarding some of the principal stocks, including local tractions. Little attention was given to the industrials. The traction stocks showed a strong tone, Manhattan being the object of renewed reports of buying by the Vanderbilt interests. A more plausible reason for its advance from 128¾ to 137½ was that the present earnings and the prospect that with electrical equipment the property would do still better have caused heavy purchases by capitalists connected with the company, thereby rendering the stock scarce in the market. There was considerable covering of shorts in Metropolitan Street Railway, which also advanced, intimations being given that the company will soon issue $10,000,000 of new stock to be subscribed for at par by the present stockholders. After having reached 171¼, the closing price of Metropolitan on Saturday was 168½, the sales aggregating 92,100 shares, Brooklyn Rapid Transit ranged between 67⅛ and 69¾, closing at 67½, a net loss of 1⅛ points, the sales aggregating 85,160 shares. On Wednesday many extravagant rumors regarding General Electric were current. It was hinted that a large stock dividend would be declared, not for several months, perhaps, but that it would be fully 50 per cent, if not 66⅔ per cent. With it is to go, according to the rumors, a cash dividend of 15 per cent. Only 4700 shares changed hands during the week, quotations ranging between 257½ and 263½, closing at 263, a net gain of 5 points. Western Union made a net gain of 1¼ points, closing at 91⅜. In the outside market Electric Boat preferred on Saturday opened at 45 and advanced to 50 on the purchases of 300 shares. Following are the closing quotations of Tuesday, Nov. 26:

NEW YORK.

	Nov. 19.	Nov. 26.		Nov. 19.	Nov. 26.
American Tel. & Cable..	96	—	General Electric.....	257½	274
American Dist. Tel.....	36	—	General Carriage.....	¾	⅛
Brooklyn Rapid Transit.	68¼	67½	Hudson River Tel.....	110	112
Ches. & Pot. Telephone..	—	—	Illinois Elec. Veh. Trans.	—	—
Commercial Cable.....	170	—	Metropolitan Street Ry..	168¾	167¾
Electric Boat.....	17	20½	N. E. Elec. Veh. Tran...	—	—
Electric Boat pfd.....	40	47	N. Y. Elec. Veh. Tran...	5⅛	9¼
Electric Lead Reduc'n...	1⅞	2	N. Y. & N. J. Tel.....	166	166
Electric Vehicle.....	2¼	2	Tel. & Tel. Co. of Am..	—	—
Electric Vehicle pfd.....	4½	4¼	Western Union Tel.....	90⅝	91⅜

BOSTON.

	Nov. 19.	Nov. 26.		Nov. 19.	Nov. 26.
Am. Tel. & Tel.....	157	160	Mexican Telephone.....	2	2
Cumberland Telephone...	—	—	New England Telephone.	132	—
Boston Electric Light...	—	—	Westinghouse Elec.....	70	—
Erie Telephone.....	21¼	24	Westinghouse Elec. pfd.	—	—
General Electric pfd....	—	—			

PHILADELPHIA.

	Nov. 19.	Nov. 26.		Nov. 19.	Nov. 26.
American Railways.....	44½	45½	Phila. Traction.....	97⅛	97½
Electric Storage Battery.	57	58	Philadelphia Electric....	5	5
Elec. Storage Batt'y pfd.	57	58	Pa. Electric Vehicle.....	¾	¾
Elec. Co. of America....	6⅞	6½	Pa. Elec. Veh. pfd.....	1	1

CHICAGO.

	Nov. 19.	Nov. 26.		Nov. 19.	Nov. 26.
Central Union Telephone.	40	—	National Carbon pfd.....	84	83
Chicago Edison.....	—	155	Northwest Elev. com....	39	36
Chicago City Ry.....	188	188	Union Traction.....	12⅜	11⅜
Chicago Telep. Co.....	—	225*	Union Traction pfd.....	52½	47¼
National Carbon.....	20	19½			

*Asked.

WASHINGTON TRACTION SECURITIES.—Under a decree of the United States Circuit Court, in the suit of the United States Mortgage & Trust Company, trustee, against the Washington (D. C.) Traction & Electric Company, the stock and bonds of the various properties of the latter company, covered by a collateral trust mortgage, were sold at auction at Norfolk, Va., on Nov. 23 for $5,000,000. The stocks and bonds were bought in for the reorganization committee. The purchasers were Julien T. Davies and Brainard Tolles, of New York, who acted for the United States Mortgage & Trust Company. A large amount of the bonds of the City and Suburban and the Aancostia and Potomac railroads, which are constituent properties of the Washington Traction Company, are owned in Baltimore. The Washington Company owns 39,865 shares of the stock of the Anacostia out of 40,000 shares issued, and 30,602 out of the 35,000 shares of the City & Suburban. Other constituent lines are the Metropolitan Railroad, Columbia Railway, Georgetown & Tennallytown, Brightwood Railway, Wilmington, Woodside & Forest Glen, Washington & Great Falls, Washington & Rockville, and the Washington & Glen Echo. Of all these lines the Washington Traction Company owns 110,478 of an aggregate issue of 115,993 shares of stock, of the total par value of $5,818,100. It also owns the stocks of the two electric light plants of Washington. These securities were pledged to secure an issue of 4 per cent bonds. Default in interest on these bonds caused the foreclosure sale and the reorganization, which is the next step. The holders of a majority of these bonds have agreed to the terms of the reorganization.

ATLANTIC COAST ELECTRIC COMPANY.—William Evarts Benjamin, president of the Atlantic Coast Electric Company, which has failed to pay the interest due on some of its bonds, says: "While it has been fully determined to reorganize the finances of the company, we have not as yet mapped out our plan of reorganization. Nothing has been done except to hold up the payment of interest due Nov. 1 on its outstanding 5 per cent bonds. This, of course, draws the attention of all the security holders, and paves the way for financial reorgnaziation." Mr. Benjamin said he did not think the plan of reorganization will include the issuance of a general mortgage of $1,500,000, as has been reported. He said that all the security holders will be satisfied with the scheme of financial reorganization. The Atlantic Coast system is a combination of trolley lines from Belmar, N. J., to Pleasure Bay. The company also owns the entire stock of the Atlantic Coast Electric Light Company, which supplies the lights of Asbury Park, Neptune Township and other nearby places. The company has $1,500,000 capital stock. Its net earnings for the year ending Sept. 30, 1900, were $138,918. Among the directors are H. H. Rogers, Daniel O'Day and Colonel George B. M. Harvey, who was once president of the company.

CHICAGO TAXES.—The United States Circuit Court has refused to help the Chicago corporations in the matter of their taxes. The application of the Chicago Union Traction Company and the Consolidated Traction Company for an injunction restraining the State Board of Equalization from assessing the capital stock of these companies for 1900, was denied by Judges Grosscup and Humphrey, and the temporary injunction issued by Judge Grosscup was dissolved. No written opinion in the case was filed. Judge Grosscup stated orally at length the reasons for the decision, explaining that later Judge Humphrey would file a written opinion. This oral statement occupied 40 minutes. Immediately after the decision was announced assessments aggregating $75,000,000 and involving over $1,000,000 in 1900 taxes were made by the State Board of Equalization as the fair cash value of the capital stock of the traction companies over and above the assessment on their tangible property. The $75,000,000 valuations made take the place of $3,500,000 valuations made last year as representing the fair cash value of the property assessed. The next move is awaited with interest.

GENERAL ELECTRIC EARNINGS.—It is understood that the earnings of the General Electric Company are phenomenally large. For September the net earnings aggregated $900,000, but October net earnings broke all previous records, amounting to $1,000,000, and from orders now on hand it is known that the company will be able to show $1,000,000 net per month the balance of this year. These earnings make sure that the General Electric Company will be able to accumulate a surplus of at least $18,000,000 by April 1, which will permit the restoration of its capital to $40,000,000, as it was previous to the reduction in 1898. Its surplus now amounts to nearly $15,000,000. It would only require $8,000,000 of net earnings per annum to show 20 per cent per annum on a capital of $40,000,000 and the company will be able to show better than this for the year to end Jan. 31.

CENTRAL UNION TELEPHONE.—President Sabin, of the Central Union (Bell) Telephone Company, has sent to stockholders a report of the business done by months so far this year. The statement shows a considerable gain in the number of exchange stations and rental earnings, and in the gross revenue of the company. For instance, the rental earnings in January were $126,411 and in October $153,770. It is estimated in the circular that the rental earnings for November will be $156,000, and in December $160,000. At the time of Mr. Sabin's connection with the company in April there were 75,341 stations. At the end of October there were 91,485, a gain of 16,144. Gross revenue for January, 1901, was $192,889 for August, 1901, $220,435.

LIGHTING CONSOLIDATION AT PORT JERVIS, N. Y.—A certificate consolidating the Port Jervis Light & Power Company,

the Deer Park Electric Light Company, of Port Jervis, Limited, and the Port Jervis Gas Company, has now been filed with the Secretary of State. The name of the new corporation is the Port Jarvis Electric Light, Power & Gas Company, and it is to operate in the town of Deer Park, Orange County, and Pike County, Pa. The capital is $400,000, and the principal office will be at Port Jervis. The directors are Ralph S. Weaver, Benjamin Ryall and W. A. Parshall, of Port Jervis; R. H. Beach, of East Orange, N. J., and C. R. Horn, of Catasauqua, Pa. The consolidation has already been noted in these columns.

CHICAGO ELEVATED BONDS.—Directors of the Chicago Northwestern Elevated Railroad are to meet this week to decide the terms on which about $4,000,000 additional bonds will be issued. These are part of the $5,000,000 which the directors still have authority from shareholders to put out. The bonds will be offered to shareholders at a price in the neighborhood of the market value, 96⅛ to 96¼, but some rights will be given. The last bonds issued were offered to shareholders for 90, but it was not expected that shareholders would profit as much from the present lot. The old 5 per cent bonds will be called for redemption on Jan. 1. Many of these bonds have been taken up already by the company at 105.

TELEPHONE, TELEGRAPH & CABLE.—The Boston & New York, the Knickerbocker and Massachusetts Telephone companies have been absorbed by the Telephone, Telegraph & Cable Company of America, and they will hereafter be operated as one company, eliminating local organizations.

Commercial Intelligence.

THE WEEK IN TRADE.—Mild weather and car shortage have had a visible effect in trade and industry. The former condition manifests itself in the limited consumptive demand in some sections, yet the reorder demand from jobbers the country over and the inquiry for holiday goods are equal to, and in the latter case, superior to those of recent preceding years. The car shortage grows worse instead of better, and many industrial centers report interruption to trade and industries, and limited volume of shipments as a consequence. In the iron and steel market, prices have advanced, pig iron being 50 cents to $1 a ton higher at nearly all markets. While the car shortage has curtailed business somewhat, the unprecedented demand for production and consumption is largely responsible for the higher prices. Some works in the Pittsburg district are somewhat hampered on account of the lack of supplies of pig iron. Steel billets are scarce at $28 per ton. Finished products are without much change, but Central Western mills will not promise deliveries of steel bars inside of 60 days, while structural material is hard to get. The gross earnings of leading railways for three-fourths of the current year aggregate $934,742,540, which is an increase of 12.1 per cent over the same period last year. The net earnings amount to 15.8 per cent greater than those for the same nine months of last year. The failures for the week, as reported by *Bradstreet's*, aggregated 223, as against 213 the week previous, and 215 the same week last year. Copper was dull throughout the week and transactions were very few. Quotations are 16½@16¾c. for Lake, 16¼c. for electrolytic in cakes, wire bars and ingots, 16c. in cathodes and 15¾@16c. for casting copper. The United States production in October showed an increase of 3.2 per cent, which makes the output for the ten months about .1 of 1 per cent greater than that for the same period last year.

EXPORTS OF ELECTRICAL MATERIAL AND MACHINERY.—The following are the exports of electrical material, machinery, etc., from the port of New York for the week ended Nov. 13: Antwerp—Machinery, 2 pkgs., $90; materials, 16 pkgs., $1,066. Amsterdam—Material, 1 pkg., $75. Argentine Republic—Materials, 83 pkgs., $2,125. British Possessions in Africa—Material, 1 pkg., $10. British East Indies—Materials, 9 pkgs., $191. Baden—Materials—1 pkg., $300. British Australia—Materials, 41 pkgs., $2,263. Chili—Materials, 15 pkgs., $520. Cuba—Materials, 65 pkgs., $2,543. Central America—Materials, 22 pkgs., $570. Dresden—Materials, 1 pkg., $30. Glasgow—Materials, 1 pkg., $80. Genoa—7 pkgs., $325. Hamburg—63 pkgs., $5,836. Havre—2 pkgs., $200; materials, 1 pkg., $67. London—Materials, 97 pkgs., $4,230. Leeds—Materials, 3 pkgs., $210. Liverpool—Materials, 119 pkgs., $3,498. Mexico—Materials, 9 pkgs., $281. Milan—Materials, 3 pkgs., $250. Marseilles—Materials, 20 pkgs., $200. Manchester—Materials, 15 pkgs., $739. Nice—Materials, 1 pkg., $50. Newfoundland—Materials, 3 pkgs., $81. Nova Scotia—Materials, 1 pkg., $102. Peru—Materials, 19 pkgs., $662. Port Ross, Africa—Materials, 9 pkgs., $300. Riga—Materials, 1 pkg., $25. Rome—Materials, 2 pkgs., $100. Santo Domingo—Materials, 10 pkgs., $161. U. S. of Colombia—Materials, 6 pkgs., $76. Belfast—Machinery, 4 pkgs., $45. British East Indies—Machinery, 14 pkgs., $4,600. Bremen—Machinery, 1 pkg., $70. British Australia—Machinery, 47 pkgs., $22,471. Central America—Machinery, 22 pkgs., $570. Dublin—Machinery, 3 pkgs., $75. London—Machinery, 206 pkgs., $21,300. Leicester—Machinery, 6 pkgs., $175. Liverpool—Machinery, 219 pkgs., $29,580. Mexico—Machinery, 6 pkgs., $83. Manchester—Machinery, 94 pkgs., $7,615. New Zealand—Machinery, 2 pkgs., $50. New Castle—3 pkgs., $500. Southampton—Machinery, 1 pkg., $105; machinery, 2 pkgs., $270. U. S. of Colombia—Machinery, 3 pkgs., $213. Vienna—Machinery, 12 pkgs., $828.

WESTINGHOUSE IN ENGLAND.—A special telegram from Pittsburg of Nov. 22 says: The British Westinghouse Electric Manufacturing Company, which is building a great plant in England, is now selecting the workmen who will have charge of its plant. These, so far as the managing and important positions are concerned, will be filled entirely with Americans from the works at East Pittsburg, near this city, the site of the plant of the Westinghouse Electric & Manufacturing Company. As the British works are to be an almost exact duplicate of the plant here, the men selected will not find much change except that they will be placed over men for the most part English. About 100 managers, foremen and others are now being advanced. They are all skilled mechanics who have been with the company for many years. A number have been offered positions more lucrative in the English plant, but have preferred to remain in the United States. The general manager of the British plant will be William Lownes, of Pittsburg. Another feature of the planting of the American industry in British soil is that 120 young Englishmen are now at the Westinghouse works here becoming familiar with the workings of the concern. They are mostly from the mechanical and polytechnic schools of Manchester, and were selected by the British investors in the enterprise. They will be made assistant foremen, etc., and from among them are to be picked the future foremen, managers, etc., as the places held by the men who go from here to establish the industry become vacant.

THE TROLLEY IN MEXICO.—The journal of the Bureau of American Republics has the following: Reports state that Senor Vales Castillo, of Merida, Yucatan, Mexico, and Senor Julio Rendon, manager of the Progreso Lighterage Company, now in New York City, and who can be addressed care Mr. F. G. Canton, 29 Broadway, New York, propose to soon build an electric road 25 miles long between Merida and Progreso. Senores Ricardo C. Rivas and Galvas, Merida, also propose to build an electric road in Merida, to cost about $500,000. It is stated that a company is being organized to convert the Ferrocarril Muelle y Almancenes del Comercio de Progreso into an electric road and extending the same, at a cost of about $150,000. All the materials for these projects will be purchased in the United States.

PNEUMATIC TOOL COMBINATION.—A plan is now being attempted to organize a pneumatic tool consolidation, to include both British and American concerns, to be known probably as the Chicago Pneumatic Tool Company, and capitalized at $10,000,000. The purpose is to unite all the concerns engaged in the production of pneumatic machinery, such as drills and riveters, which are used extensively in mining, submarine and bridge work, as well as in steel working and railroad shops. It is proposed to include the following companies: The Chicago Pneumatic Tool Company, the Boyer Machine Company, of Detroit; the Franklin Air Compressor Company, of Cincinnati, and the Tate Howard Company, of Manchester, England. J. W. Duntley, president of the Chicago Company, is at the head of the new company.

STREET RAILWAY STORAGE BATTERIES.—The Electric Storage Battery Company, of Philadelphia, has installed 158 sets of batteries of Chloride accumulators in street railway service for the purposes of regulation, carrying the peak during heavy traffic and for use in emergencies. These batteries representing over 103,000 kilowatt-hours of output, are installed in power houses, sub-stations and rotary transformer stations, and cover every application of storage battery to street railway service. Among recent installations are those for the Detroit United Railway, consisting of 250 cells; the Chicago City Railway, 250 cells; the Southern Ohio Traction Company, 290 cells, and the Fairmount & Clarksburg Railroad, 250 cells.

BULLOCK APPARATUS FOR CANADA.—Another large three-phase alternating-current generator is being shipped to Canada from the Bullock plant at Norwood, Ohio. It is to be installed in the plant owned by M. P. Davis at Shieks Island, and is rated at 1350 horse-power. The normal operating speed of the machine is 180 revolutions, and it is to be direct coupled to a Hamilton waterwheel. In the official test, the dynamo was operated for a short period at 50 per cent over speed at which time the peripheral speed reached the high rate of 10,400 ft. per minute. The Bullock Company's works are crowded with orders for large machines and necessary extensions to the plant are now being made.

ELECTRIC TRACTION AT SHANGHAI.—Shanghai is to have an electric traction system, a special meeting of the ratepayers (mostly Britishers) of that Chinese city having passed a resolution to advertise for tenders to construct and operate an electric traction system. The municipality reserve the right to take over the undertaking within a given period, and under conditions to be determined on in the near future. A Mr. Hans Ziegler, said to represent British electrical interests, has been making overtures to the Shanghai authorities for some time past, but his propositions have been rejected. Mr. J. S. Fearon, of the commission house of Fearon, Daniels & Co., of 87 Front Street, New York City, who is now in China, has taken a leading part in the deliberations of the Shanghai authorities regarding the project. Several years ago a steam road was operated between Shanghai and several towns within a radius of some 30 miles. The extreme popularity of the road, however, caused its discontinuance, as the Chinese Government considered it was too much of an object lesson for the natives, and the road was purchased at an exorbitant figure by the authorities, who shipped the entire rolling stock to the island of Formosa, where it was dumped. The Chinese Government will have no jurisdiction over the contemplated electric traction project, as the road will operate within the foreign settlements.

BIG NEW ENGLAND TROLLEY SYSTEM.—At the first meeting of the Boston & Worcester Street Railway Company, held last week, officers were elected and contracts aggregating more than $1,500,000 for the construction of a new street railway line from Boston to Worcester were awarded. The new officers are: William Butler, president; H. Fisher Eldridge, of Portsmouth, N. H., vice-president; George A. Butman, of Boston, treasurer; H. W. Sprague, Arthur E. Childs, W. H. Trumbell, of Boston; Charles C. Pierce, of Brookline; John H. Whipple, of Brockton; Albion R. Clapp, of Wellesley; Fred C. Hines, of Newton; Charles W. Shippee, of Milford, and Alexander B. Bruce, of Lawrence, directors. Contracts were given to J. F. Shaw & Co. for the immediate construction of the line. The company has started work on a power station at Framingham, whence the line will be operated. The rails and ties have been distributed between Framingham and Natick. The Framingham, South Borough and Marlborough, the Framingham Union, and the Marlborough Street Railways, which have been acquired by the new company, will be operated from power stations already in use, and the company will have car barns at Wellesley and Westborough. Application will be made at once to the Selectmen of Wellesley for a location in that town in order to complete the line from Boston to Worcester.

THE JAMES LEFFEL & CO., of Springfield, Ohio, report the following recent sales and shipments of their steam engines and boilers: 8 by 10 engine for Porto Rico, to be used in driving machinery made only in England, for a special purpose; complete new outfit of 50-hp automatic engine, with 60-hp boiler for a modern flour mill plant in Wisconsin; complete new outfit of 8 by 10 engine, with 25-hp boiler for a hat factory at Oaxaca, Mexico; 6½ by 10 automatic engine for an electric plant on a plantation near Santiago, Cuba; 6-hp horizontal engine and boiler mounted on skids for driving a portable wood-sawing outfit in Wisconsin; 6½ by 10 engine and boiler complete for Barranquilla, Colombia, S. A.; 7½ by 10 automatic engine, and 3-hp vertical engine and boiler for customers in Spain; 7 by 10 engine and boiler for Monterey, Mexico; 9½ by 12 automatic engine for flour mill at Decatur, Ind. This company is also installing considerable new equipment in the way of machine tools, new power plant, including a 100-kw direct-connected unit, new blower system of heating, new electric traveling crane over a large erecting floor, new down-draft furnaces in connection with a new blacksmith shop equipment, etc. When completed, they will have one of the most modern and up-to-date shops extant specially adapted for producing their output, consisting entirely of waterwheels, steam engines and boilers.

ELECTRICAL PLANT FOR PORTO RICO.—Some important contracts have just been awarded in connection with the irrigating and electrical plants of the South Porto Rico Sugar Company's Guanica property located on the southern side of the island. The General Electric Company is to furnish two 250-kw dynamos with exciters, panels, etc.; six transformers; the same number of induction motors aggregating 350 horse-power, and two 75-kw rotary converters with transformer panels, etc. The Sterling Boiler Company, 26 Cortlandt Street, is to build three 200-hp water tube boilers, while the engines—two compound condensing machines of 320 horse-power each—will be manufactured by the Fitchburg Engine Company, of Fitchburg, Mass. The contracts for the pumping equipments to be utilized for irrigating purposes and consisting of six pumps, having a capacity in all of 20,000,000 gallons per day, will be let within the next few days. The before-mentioned contracts were placed through Mr. Percival R. Moses, electrical engineer, of 35 Nassau Street, New York City.

LARGE BATTERY MANUFACTURING PLANT.—The Nungesser Electric Battery Company, of Cleveland, Ohio, has commenced work on what is claimed will be the largest plant in the country devoted exclusively to the manufacture of electric batteries. The new building will be 130 by 140 ft., and two stories high, and will be located at King Street and the Lake Shore Railway. By reason of the immense and constantly growing demand for telephone and other batteries, the present plant, which has a capacity of 4000 cells per day, is entirely inadequate to the demands, despite the fact that important additions have been made during the past year. With the new plant in operation, the company will have a capacity of over 10,000 cells per day. Nungesser batteries go largely to jobbers, and shipments of 25,000 to 50,000 cells are not unusual. It is probable that before long the company will announce a new storage battery upon which Mr. Nungesser has been at work for some time.

BALL ENGINE ORDERS.—The Columbia Plate Glass Company, of Blairsville, Pa., has recently ordered an electric plant. One 300-hp and one 80-hp direct-connected Ball engines supply the power. The Wills Creek Coal Company, Byesville, Ohio, is about to install a 175-hp engine, built by the Ball Engine Company, Erie, Pa. The Jacksonville Gas Light & Coke Company, Jacksonville, Ill., is making quite an increase in its electric plant. The Ball Engine Company will build the engine, a 500-hp cross compound direct connected to a General Electric generator. The Ball Company is also furnishing an engine arranged for direct connection to a Sprague generator, to the Indiana Elevator, Chicago.

AIR POWER CARS A FAILURE.—The compressed air cars run on Twenty-eighth and Twenty-ninth streets before the Metropolitan Street Railway Company abandoned the experiment and went back to horse-power on those lines, have now been moved up to the car-barns on the Harlem flats near 216th Street and Kingsbridge Road. The Compressed Air Company officials claim that the cars were worn out by the heavy traffic which was carried on them. The cars are being stowed in winter quarters along with many open cars. Their ultimate failure and removal has been predicted several times in these pages, and it is believed they will stay permanently out of commission.

BOILERS FOR TRINIDAD LIGHTING PLANT.—The electric lighting plant of the Trinidad Electric Company, Limited, the Canadian-American enterprise, which is about to operate lighting and traction systems in Port-au-Spain, Trinidad, British West Indies, is to be equipped with two 250-hp boilers from Thayer & Co., incorporated, 39-41 Cortlandt Street, New York City. The boilers will be built by the Aultman & Taylor Machinery Company, of Mansfield, Ohio. It will be recalled that T. W. Teele, formerly of the Boston Elevated Railway, is manager of the Trinidad Company, and that Walter P. Plummer, Cable Building, 621 Broadway, is purchasing agent.

THE TRIUMPH ELECTRIC COMPANY, of Cincinnati, has just sold to M. A. Bradley, of Cleveland, a 200-kw, three-bearing generator. The same company secured the contract for the installation of the new apparatus for the new Globe-Wernicke plant in Norwood, consisting of one 200-kw direct-connected generator, five 30-hp motors, three of 65 horse-power, two of 20 and two 10-hp motors. The Triumph Company furnished in prior orders about 1400 horse-power. The Tribune Company, Cincinnati, has contracted for one 200-kw and one 100-kw direct-connected generators.

SMITH-VASSAR TELEPHONE COMPANY DISSOLVED.—Judge McAdam, of the New York Supreme Court, has granted an order dissolving the Smith-Vassar Telephone Company, of 27 William Street, and appointed Herman W. Williams receiver with a bond of $500. Proceedings for the voluntary dissolution of the corporation were begun a year ago. The company was incorporated on Oct. 25, 1895, with a capital stock of $1,000,000. The annual report of the company filed in January last showed liabilities of $100,000.

LARGE POWER HOUSE.—It is stated that the Everett-Moore syndicate is preparing to build one of the largest power houses in the world from which it will operate the city lines and a portion of the interurban system of the Detroit District Railway. It is stated that about $1,000,000 will be devoted to new equipments for the new system and between $1,000,000 and $2,000,000 will be expended for power houses.

NEW WESTERN ELECTRIC BUILDING.—The Western Electric Company has been granted a permit to erect a ten-story office and factory building in connection with its present plant at 277 Clinton Street, Chicago. The new building will be 55 by 151 ft., and will cost $172,000.

POWER IN MONTANA.—The Madison Canyon Electric Power Company is pushing work on an immense power plant to cost about $5,000,000 to furnish power for most of Madison County, besides Butte.

General News.

THE TELEPHONE.

FORT SMITH, ARK.—A line of the National Telephone Company is being built from Caney, Kan., to Collinsville, I. T.

SAN FRANCISCO, CALIF.—The Pacific States Telephone & Telegraph Company has leased a building in order to provide larger quarters for its local exchange in Redlands, Calif., where many improvements will be made in the service.

BAKERSFIELD, CALIF., has the largest number of telephones of any of the towns on the Pacific Coast, in proportion to population. There are in actual use 935 telephones. The switchboard in the local exchange is to be enlarged at once to keep pace with the growth of business.

SAN FRANCISCO, CALIF.—The Western Union Telegraph Company's business in California has grown considerably within the past few years, notwithstanding the fact that one of the best long distance telephone systems in the world covers the State and the coast. A new copper wire was recently completed from Chicago to Los Angeles, via El Paso, with a special view to the growing fruit business of Texas. An additional telegraph wire is being strung from Chicago to the Pacific Coast touching San Francisco and Los Angeles, via Omaha, Denver, Albuquerque and Barstow. This line, which will soon be completed, will run parallel with the Santa Fe Railroad.

DENVER, COLO.—The Rocky Mountain Bell Telephone Company has just received franchises to build exchanges in Casper, Douglas, Lander and Thermopolis, Wyo., and is building some 250 or 300 miles of territorial lines.

GREENVILLE, ILL.—The Greenville City Council has granted to J. H. Steinhaus a telephone franchise.

JERSEYVILLE, ILL.—The Calhoun County Telephone Company has decided to extend its lines into St. Louis.

LEWISTOWN, ILL.—The City Council recently granted a 99-year franchise to the Lewistown Automatic Telephone Company.

GRIGGSVILLE, ILL.—The Farmers' & Merchants' Union Telephone Company has certified to an increase of capital stock from $2,500 to $20,000.

MOLINE, ILL.—A temporary injunction has been granted to the East Moline Company which restrains the Crescent Telephone Company—the independent concern at Port Byron which has been building a toll line to Moline—from building through East Moline.

VINCENNES, IND.—A visit to Indianapolis and a close inspection of the new telephone plant at that place by a company of prominent citizens has resulted in a movement to put in an independent telephone plant in this city.

INDIANAPOLIS, IND.—The New Lisbon Telephone Company has been incorporated with a capital of $5,000. The company will operate in Dudley, Liberty and Henry Townships in Henry County. Mr. John A. Miller heads the board of directors.

INDIANAPOLIS, IND.—The Board of Public works has granted to the Central Union Telephone Company permission to construct underground conduits in the territory north of Twenty-first Street. The company proposes to establish a branch telephone exchange at Pierson Place and Twenty-first Street.

MARION, IND.—The United Telephone Company has awarded the contract for the underground and the ærial cable systems, for its new plant in this city to F. B. Bissell, of Toledo, Ohio, and J. F. Butterfield, of Chicago. The contract price is $40,000. There will be 60,000 feet of underground and 50,000 feet of overhead cable work.

NEWTON, IA.—A telephone company has been organized among the merchants of Baxter and influential farmers residing northwest of that town.

SIOUX CITY, IA.—The Sioux City & Black Hills Telephone Company has been organized at Ponca, Neb., with $100,000 capital to build a toll line from Sioux City to the Black Hills, 520 miles. The officers are: J. J. McCarthy, Ponca, president; E. E. Hallstead, Ponca, secretary; F. B. Row, Sioux City, manager.

TOPEKA, KAN.—The Independent Telephone Company is planning to build a line from Topeka to Meriden, which will give connections between the Topeka line and the independent line reaching from Atchison to Meriden.

TOPEKA, KAN.—The Kansas City Council has granted a 30-year telephone franchise to John Enoch. This franchise will be used to organize a Kansas City terminus for the Kansas Independent Telephone Company, of which B. F. Pankey is one of the promoters.

HARTFORD, KY.—A battle royal is on between the Rough Rider Telephone Company, a local enterprise, and the Cumberland Company, which seeks to drive the former out of business by low rentals. The Rough Rider Company is preparing to build a line to Morgantown, Ky.

MENOMINEE, MICH.—A twenty-one-year franchise has been granted the Green Bay & Lake Michigan Telephone Company, owned by ex-Governor Schofield and A. L. Hutchinson, by the Council. The line is to be extended from Escanaba to Milwaukee.

ST. JOSEPH, MO.—Mr. Lyle, of Maysville, has sold his telephone line in DeKalb County, and the two companies have been merged into one.

JEFFERSON CITY, MO.—The Harrison County Mutual Telephone Company, of Brooklyn, capital stock $9,000, has been incorporated by E. Reynolds, F. Davis, J. L. Stanton, and others.

RED LAKE FALLS, MINN.—A telephone line from Third River Falls to Roseau is projected. H. Fant is the projector.

CONCORD, N. H.—The New England Telephone Company is preparing to construct a line from Franklin to White River Junction.

GLENVILLE, NEB.—A telephone company has been formed at this place.

PLATTSMOUTH, NEB.—The Plattsmouth Long-Distance Telephone Company has made application for a franchise in South Omaha. It offers to make a reduction of 30 per cent in all telephones and to furnish the city departments with instruments free of charge.

COHOES, N. Y.—The Dolgeville Telephone Company has been sold to the Interstate Telephone Company of Little Falls.

NEWBURGH, N. Y.—An application for a franchise for a new telephone system is being considered by the Catskill Board of Trustees.

WILLIAMSBURG, OHIO.—A franchise has been granted to the Citizens' Telephone Company to build and maintain an exchange in this place.

NEVADA, OHIO.—The telephone exchanges at Wyndor and Nevada are being connected by a toll line which is being built by both companies.

MARIETTA, OHIO.—The Bell Telephone Company is at work on a new exchange building at Marietta. Cables are being laid on several of the business streets.

EAST HAMILTON, OHIO.—The City & Suburban Telephone Association, of Cincinnati, has been granted a franchise to erect and maintain a system in East Hamilton.

UPPER SANDUSKY, OHIO.—The United States Telephone Company has filed a $1,000,000 mortgage here to the Cleveland Trust Company on all its property in Ohio.

MT. VERNON, OHIO.—H. C. Devin and E. W. Breece, of the Mt. Vernon Telephone Company, are endeavoring to secure a franchise for an exchange in the neighboring town of Utica.

CINCINNATI, OHIO.—A temporary restraining order has been issued against the City & Suburban Telephone Association restraining it from erecting its poles and stringing wires in Delphos near Cincinnati.

WILLOUGHBY, OHIO.—At the annual meeting of the Willoughby Home Telephone Company, held a few days ago, the board of directors and officers were re-elected, the only change being in the election of J. H. Smart as secretary-treasurer, to succeed J. S. Ellen. The other officers are: L. W. Penfield, president; W. C. Collister, vice-president, Fred. Strom, general manager.

TORONTO, OHIO.—The Citizens' Telephone Company, of Toronto, which has recently succeeded the Phœnix Telephone Company, of this place, is making extensive improvements to its exchange. A combination central energy and magneto switchboard of 300 capacity is being installed by the Cleveland branch of the Kellogg Switchboard & Supply Company, of Chicago, and new instruments are being supplied to all subscribers in the town.

CLEVELAND, OHIO.—The United States Telephone Company has filed with the County Recorders of all the counties through which its lines pass, a deed of trust for $1,800,000 to the Cleveland Trust Company, supplemental to a $1,350,000 mortgage. The original mortgage was filed last year. The $450,000 increase covers improvements which have been made in the telephone system since the mortgage was made. The mortgage will be increased from time to time as the mileage of the toll lines increases.

YOUNGSTOWN, OHIO.—The exchange of the Youngstown Telephone Company occupies the unique distinction of being on stilts. The company occupies the top story of an office building and the owners of the building desired to tear it down and build a new one. The telephone company protested that it could not move without making expensive changes and disorganizing its service, and as it held a lease on the room it declined to move. Accordingly the top floor of the building was elevated on a firm base and the lower portion of the building was torn down. New foundations are being built and the new building will be eight stories high—considerably higher than the old building—so that the top floor will have to be raised from time to time. The work of the exchange goes on as usual, the room being reached by an outside stairway.

CLEVELAND, OHIO.—Through the aid of a newly organized and well equipped contract department, the Cuyahoga Telephone Company is making phenomenal gains in its subscription lists. At present the number of subscribers is something over 9000, and the manager of the department states that orders for individual telephones are coming in at an average rate of 25 per day. The company is also showing remarkable gains in its private branch exchange work. Many of the large factories and mercantile establishments have recently improved their telephone service by this convenient service, while many of the numerous large apartment houses now being erected are to be equipped with private branch exchanges. Within the past sixty days branch exchanges have been installed in three factories, four mercantile establishments and four apartment houses, and others are to be installed as soon as the apparatus can be secured.

WELLSBORO, PA.—Work has been begun on a telephone line between Liberty borough and Roaring Branch.

SCOTTSBORO, TENN.—A new telephone system is being installed here which will give two exchanges for Scottsboro. The line is being built from Bridgeport to Huntsville.

NASHVILLE, TENN.—The Richland Telephone Company, of Grainger County, has been incorporated; capital stock, $1,000. Wm. Stone, Sam McBee, A. E. Foster, W. A. Frazier and Sam McKinney are the incorporators.

LA CROSSE, WIS.—The Hillsboro and Wonewoc Telephone Company will lease the Viroqua & Wonewoc branch of the La Crosse & Southwestern Telephone Company's line.

MADISON, WIS.—The Milwaukee Telephone & Telegraph Company, with the general purpose of using and licensing others to use all sorts of devices for conveying sound, has filed articles of association with the Secretary of State. The capital stock is $25,000, and the incorporators are F. C. Winkler, Edwin Reynolds and E. A. Wadhams.

FOND DU LAC, WIS.—The much-rumored consolidation of all the independent telephone companies in Wisconsin will probably be effected early in the spring. This information comes from one of the directors and principal stockholders of the Little Wolf River Telephone Company. The consolidation will greatly increase the efficiency of the service of the various companies to enter the combination and will probably require the construction of a number of additional toll lines and exchanges throughout the State.

ELECTRIC LIGHT AND POWER.

SAN FRANCISCO, CALIF.—The citizens of Haywards, Calif., are agitating the question of arranging for a bond issue for the purpose of acquiring the electric lighting plant now operated by a private concern. A municipal water plant may also be provided for.

FRESNO, CALIF.—The citizens of Fresno will decide, at special elections, whether or not they are in favor of municipal ownership of public utilities. One proposition is to vote for $250,000 worth of water bonds, and the other is for bonds, in the sum of $250,000, to install a municipal lighting plant.

ALAMEDA, CALIF.—The Board of City Trustees of Alameda recently decided to increase the capacity of the municipal electric lighting plant and to reject a proposal made by the Oakland Gas, Light & Heat Company, to supply Alameda with electric current for lighting after midnight. Bids have been called for for an additional engine and dynamo.

LOS ANGELES, CALIF.—The Kern Power Company, with a capital of $5,000,000, fully subscribed, has filed papers of incorporation. It proposes the manufacture of electricity for light, heat, and power; also the acquirement of water rights, the construction of bridges and pipe-lines, and the obtaining of all kinds of franchises. The directors are H. E. Huntington, S. W. Hellman, A. Borel, C. De Guigne, W. G. Herckhoff, A. C. Balch, and H. W. O'Melveny. It is proposed to obtain power on Kern River, 150 miles north of Los Angeles.

SAN FRANCISCO, CALIF.—The city trustees of Riverside, Calif., recently received two propositions to furnish the town with electricity for municipal lighting and power. The municipality owns an electric transmission line and has been buying current from private companies. Judge Campbell offered to construct a 600 horse-power generating plant on Lytle Creek, using hydraulic power. At the end of thirty years he would turn the plant over to the city free of charge. He wishes to sell electric power to the city at a rate of $6 per horse-power per month, for a minimum of 350 horse-power, and would charge but $5 per horse-power for all additional power used. The Mt. San Bernardino Power Company offered to install an electric power plant on Mill Creek, to pay $15,000 for the city's transmission line and to supply the city with 400 horse-power at $2,000 per month. It will guarantee the municipality against loss by failure of the plant and will give bonds to complete the plant by Dec. 31, 1902.

WILMINGTON, DEL.—The Standard Light Company, of Wilmington, has been chartered to manufacture and deal in incandescent lights and electrical fittings; capital, $500,000.

MONTICELLO, ILL.—The Monticello Electric Light Company, of Monticello, has certified to an increase of capital stock from $10,000 to $20,000.

SPRINGFIELD, ILL.—The Genoa Electric Light Company, of Genoa, has been incorporated; capital stock, $10,000; incorporators, George Loptien, H. L. Canfield and A. C. Anderson.

CUMBERLAND, MD.—The Cumberland Electric Light & Power Company has been incorporated with $50,000 capital by Charles W. Kilbourn, New Brunswick, N. J.; Arthur Le Roy Fell, Washington, D. C.; Arthur L. Bosley, Baltimore, and Duncan Sinclair and John G. Wilson.

GRAND RAPIDS, MICH.—The Edison Light Company has decided to install a new 1500-hp engine and generator of 1000 kilowatt capacity. The new machinery has not yet been purchased. It will supplant a 1000-hp. unit. The company has nearly completed the work of taking down poles and installing an elaborate conduit system.

CHILLICOTHE, MO.—John Doll and P. A. Gibson, of Erie, Pa., are in Chillicothe looking over the field with a view to buying Chillicothe's electric light plant and building an electric railway from Chillicothe to Trenton. All they ask from Chillicothe is right of way in Livingston County. They would also expect a street lighting contract with the city.

WILMINGTON, N. C.—The Wilmington Gas Light Company has obtained control of the street railway and electric light plants in this city.

ASHEVILLE, N. C.—Ladshaw & Ladshaw, of Spartanburg, S. C., have completed plans for the W. F. Weaver Power Company for the construction of an electric power plant on the French Broad River, six miles from Asheville. The plant will cost about $200,000 and two 750 kilowatt generators will be installed. The power will be utilized for operating a cotton mill and an electric railroad.

GOLDSBORO, N. C.—The special committee has reported to the Aldermen regarding an inventory of the plant of the Goldsboro Electric Light Company, and probable cost of same. The committee recommended that the city purchase the plant for $25,000. The Board of Aldermen adopted the recommendation, and the action will be taken as soon as the city floats the bonds and secures the money.

JERSEY CITY, N. J.—The American Town Lighting Company, Jersey City, capital $1,000,000, has been incorporated by Henry N. Gallaudet, Elizabeth; John J. Daly, Brooklyn, N. Y.; Edwin B. Ware, New York; Archie L. Wisner, New York; Joseph E. Cornigan, New York; Forsyth Wickes, New York; Joseph P. Cotton, Jr., New York.

ALBANY, N. Y.—The Adirondack Electric Company, of Lake Placid, has been incorporated; capital, $100,000. Directors: A. W. Boynton, Keesville, and H. S. Isham and F. A. Isham, Lake Placid.

ALBANY, N. Y.—The Century Light & Power Company, of New York City, has been incorporated; capital, $150,000. Directors: G. W. Glaentzer, of Ridgewood, N. J.; C. B. Hobbs, of Great River, L. I., and J. D. Fearhake, of Brooklyn, N. Y.

ALBANY, N. Y.—The Madison County Gas & Electric Company, of Oneida, has been incorporated; capital, $200,000. Directors: George S. Sheppard, John A. Underwood, Fred. H. Lynn, Mark L. Wilhelm, of Penn Yan, and George M. Wilhelm, of Oneida.

MADISONVILLE, OHIO.—An issue of $25,000 for electric light and water works improvements has been decided upon by a recent vote of citizens.

BEACH CITY, OHIO.—The Tuscarora Rubber Company, which has a large plant at Beach City, has submitted a proposal to the village Council to furnish light at a cost of $75 per arc lamp.

CINCINNATI, OHIO.—The Lovercombe Gas & Electric Company, of Cincinnati, has been incorporated, with $10,000 capital stock, by Fred. A. Lovercombe, Andrew Messner, Emil Schmidlin, Alois Wuest and Thomas L. Pogue.

ANDERSON, S. C.—The Anderson Water, Light & Power Company has completed over $500,000 in improvements at its plant on Seneca River. The dam as completed is 700 feet long and 44 feet high. The power developed is 4600 horse-power, and is transmitted to Anderson, where it is utilized in various ways.

KNOXVILLE, TENN.—In Baltimore the Hambleton syndicate has transferred the property of the Knoxville Traction Company and the Knoxville Electric Light & Power Company to the trust company which has purchased it. The property transferred is worth at least $1,000,000. The Knoxville Traction Company is capitalized at $750,000, and the Knoxville Electric Light & Power Company is capitalized at $110,000, and the stock sold on the market at an advance of ten per cent.

PARIS, TEX.—The Paris Light & Power Company filed an amendment to its charter, increasing its capital stock from $60,000 to $120,000.

SALT LAKE CITY, UTAH.—A Scranton, Pa., syndicate has just begun to break ground near Hailey, Idaho, for a 25,000 horse-power electric power plant for its three big quartz mills at that place. Shoshone Falls will be used for power. The company will also furnish power to Wood River Camp and the new copper camp at Contact, Nev., nearly fifty miles distant. In addition to this a trolley line will be built on the old stage line that runs to Shoshone Falls. It is said that the company will expend $2,000,000 on this new scheme. The company proposes to furnish power and light to all the towns and mining camps within a radius of 100 miles.

RICHMOND, VA.—The Virginia Electrical Railway & Development Company has closed a contract with the Electric Storage Battery Company, of Philadelphia, for a storage battery plant, the building for which will be located immediately adjoining the power-house of the company.

NORFOLK, VA.—The president of the Norfolk Heat, Light & Power Company, Mr. W. D. Pender, states that the company will be prepared to furnish electric power by the middle of December, if the Council decides that the company can use overhead wires. The matter rests with the Board of Electrical Control.

LEESBURG, VA.—The Leesburg Council has granted a franchise to Mr. Beverly Chichester for the erection of poles on the streets of Leesburg by a new electric light company, which will shortly erect a new plant here. This franchise was granted because of the unsatisfactory service of the plant now in operation.

SEATTLE, WASH.—The Great Northern Railroad Company is investigating the project of utilizing the surplus water power of Snoqualmie Falls, about 30 miles from Seattle, Wash., to operate electric locomotives to haul its trains from Seattle to the summit of the Cascade mountains. If the Great Northern's long distance transmission plan is proven to be feasible, the Northern Pacific Railroad Company will possibly obtain electric power from the same source to operate its trains from Seattle and Tacoma to the Cascades' summit. It is asserted that the available capacity of Snoqualmie Falls is 100,000 horse-power. The available head is 270 feet and only 10,000 horse-power are now developed for electric light and power supplied to Tacoma and Seattle.

MADISON, WIS.—The La Crosse Gas & Electric Company, with a capital stock of $600,000, has filed articles of association. The incorporators are W. Cargill, William S. Cargill and George MacMillan.

THE ELECTRIC RAILWAY.

DENVER, COLO.—It is reported that a company has been formed in Denver with a capital of $300,000, to build an electric railway from Denver extending into Ouray County, Colo.

SPRINGFIELD, ILL.—Charles C. Carroll, of this city, and D. B. Powell, of St. Louis, have sold the electric railroad on the Eads bridge at St. Louis to a syndicate of capitalists representing New York, Chicago, St. Louis and East St. Louis. The purchase price has not been made public.

INDIANAPOLIS, IND.—The Indianapolis & Martinsville Rapid Transit Company has increased its capital stock from $100,000 to $750,000.

ELWOOD, IND.—The Union Traction Company will extend its line from this city to Tipton and thence to Kokomo. Three more extensions are proposed.

UNION CITY, IND.—The City Council has granted a franchise to the Richmond, Union City & Portland Interurban Company to operate over the streets of this city.

EATON, IND.—The Muncie, Hartford & Fort Wayne Traction Company has given a contract to the E. P. Roberts Company, of Cleveland, Ohio, for a power house to be built in this city at a cost of $125,000.

FT. WAYNE, IND.—An important consolidation of interurban companies was effected here on Nov. 14, when the Toledo & Bryan Air Line Company merged its interests with those of the Indiana & Ohio Traction Company in a new corporation entitled the Ohio & Indiana Air Line, which will build a line from Toledo, Ohio, to Marion, Ind. The new company's lines when completed from Toledo to Marion will be 147 miles long.

BALTIMORE, MD.—Ex-Senator M. C. Alford, of Kentucky; W. J. Loughbridge, vice-president of the Third National Bank of Lexington, Ky., and Senator George D. Davis, of Detroit, Mich., are among the directors in a company organized to build a system of 140 miles of electric railways, of which Lexington will be the center. It will probably be built to connect the towns of Versailles, Frankfort, Paris, Georgetown, and other communities in the Blue Grass region. The company represents $7,000,000 capital stock and will construct a light and power plant at Lexington.

SARANAC, MICH.—At a special meeting of the City Council a franchise for an electric railway was granted to E. L. Alvord and I. F. Tucker, for the Saginaw & Grand Rapids Electric Street Railway through the village.

CONCORD, N. H.—Wallace D. Lovell says that if the citizens of Dover, Concord and the intermediate towns will raise $200,000 he will furnish the remainder of the $1,000,000 required for the construction of an electric railway between the two cities, for which he holds a charter granted by the last Legislature.

NEWARK, N. Y.—The construction of the Newark-Marion electric trolley line is assured. The contractors are Taylor & Tyles, of Worcester, Mass.

UTICA, N. Y.—The announcement is made that a trolley line will be constructed through the eastern side of the Adirondacks from Lake Champlain to Lake Placid. The starting point will be Keesville, and the route via Ausable Forks and Upper Jay. A company has been organized.

OTTAWA, OHIO.—The Toledo & Lima Traction Company has been granted a franchise through the town of Ottawa.

CINCINNATI, OHIO.—The Suburban Traction Company of Cincinnati has increased its capital stock from $50,000 to $60,000.

MASSILLON, OHIO.—The Canton-Massillon Railway has applied to the Massillon Council for franchises for several lines in the city.

CINCINNATI, OHIO.—The line of the Hamilton, Glendale & Cincinnati Traction Company has just been opened between this city and Hamilton.

CANAL FULTON, OHIO.—The village Council of Canal Fulton has agreed to grant a franchise through town to the Canton, Wadsworth & Lodi Electric Railway.

TOLEDO, OHIO.—J. C. Bonner & Company, Toledo, are placing on the market an issue of bonds of the Toledo & Bryan Air Line Railway in which they are interested.

AKRON, OHIO.—The Northern Ohio Traction Company has been granted a franchise by the City Council of Akron for a new line to touch the new manufacturing district south of the city.

STEUBENVILLE, OHIO.—The Steubenville Traction Company has closed a contract for a storage battery plant at Toronto to assist in the operation of the new Toronto extension of the road.

RICHWOOD, OHIO.—The Village Council has granted a franchise through town to the Defiance, Ottawa, Kenton & Columbus Railway, which proposes to build a line from Defiance to Columbus.

COLUMBUS, OHIO.—The Cincinnati & Cleveland Traction Company has brought suit in the Ohio Supreme Court to compel the Probate Court of Hamilton County to grant the company a franchise in that county.

ALLIANCE, OHIO.—The Alliance Street Railway Company has applied to the Alliance City Council for a 25-year blanket franchise on existing lines and for certain extensions. It is probable that the franchise will be granted.

COLUMBUS, OHIO.—It is reported that the Everett-Moore syndicate has made overtures to the Columbus Railway Company with a view to absorbing the Columbus city lines. The story is denied by officials of the Columbus company.

CLEVELAND, OHIO.—The Wabash & Rochester Electric Railway Company has been organized, with Hon. D. A. Dangler, Cleveland, president; James Lynn, Wabash, Ind., vice-president, and Thomas W. Latham, Cleveland, secretary-treasurer.

YOUNGSTOWN, OHIO.—The Mahoning Valley Railway Company, of Youngstown, has been granted a 50-year franchise by the Mahoning County Commissioners to extend its Albert street line. Eventually the line is to be extended to Hubbard.

STEUBENVILLE, OHIO.—The Pleasant Heights Railway Company, which has recently completed a road in Steubenville, has secured right of way to extend the line to Mt. Calvary. It is said that eventually it will be extended to Wintersville and Richmond.

TOLEDO, OHIO.—The Toledo, Hicksville & Ft. Wayne Railway Company has been incorporated, with $15,000 capital stock, by A. K. Detwiler, Charles P. Griffin, Frank S. Harn, John Q. Tibbs, C. H. Masters, L. E. Flory, L. W. Brown, James Donnelly and Wm. O. Delaney.

TOLEDO, OHIO.—The stockholders of the Toledo & Indiana Railway Company have voted to increase the capital stock to $2,500,000. The Toledo & Indiana Construction Company will build this line, and the Toledo, Hicksville & Fort Wayne Railway. (See note in next column.)

CLEVELAND, OHIO.—The Cleveland & Warren Electric Railway is now under actual construction between Bedford and Geauga Lake, a distance of ten miles. The officers are: J. W. Conger, president; Dr. F. J. Morton, vice-president; A. B. Crafts, secretary, and Martin Dodge, general manager.

ASHLAND, OHIO.—The Wellington, Savannah & Mansfield Railway Company has purchased a site for a power-house near Savannah. C. H. Lawrence, of the International Construction Company, Toledo, which is building the road, has just returned from New York, where he placed contracts for rails and other materials.

CLEVELAND, OHIO.—The Cleveland Stock Exchange has listed the stock of the Lake Shore Electric Railway Company. The issue consists of $4,500,000 in common stock and $1,500,000 in preferred stock. The Lake Shore Electric will be bonded for $6,000,000, but only about $4,500,000 will be issued at the present time.

GENEVA, OHIO.—Construction work has been started on the power house at Geneva for the Ashtabula extension of the Cleveland, Painesville & Eastern Railway. The building will be 144x112 feet, and it will contain equipment sufficient to operate that end of the road and furnish current for lighting the city, franchise for which is now held by the Everett-Moore syndicate.

CLEVELAND, OHIO.—The Securities Company, of Cleveland, a New Jersey corporation, has qualified to do business in Ohio. Fred. S. Borton is president and George E. Bender, secretary. The company has a capital stock of $1,000,000. The Securities Company is the company organized by the Everett-Moore syndicate to handle its securities, and it has its headquarters in the Electric Building.

TOLEDO, OHIO.—The Toledo & Indiana Construction Company, of Toledo, has been incorporated with $15,000 capital stock by A. K. Detwiler, C. P. Griffin, Squire Garnsley, L. E. Florley, James Donnelly, L. W. Brown, Frank Yerbera, and W. P. Delaney for the purpose of constructing and equipping electric railways. The company will build the Toledo & Indiana Railway, which is promoted by the same people.

CINCINNATI, OHIO.—Directors of the Georgetown & Lexington Traction Company have arranged for the issuance of $250,000 in bonds to pay for the completion of the road and its equipment. The entire line from Georgetown to Lexington (Ky.) is graded. It is expected that the work will be finished and the road in operation within 90 days. The C. C. Tennis Construction Company, of this city, is building the road.

TORONTO, ONT.—Buffalo, N. Y., capitalists are negotiating for the purchase of the Peterboro & Ashburnham (Ont.) Electric Railway. If secured the purchasers intend to extend the line to Lakefield, Ont., a distance of seven miles, and will also equip the road with new rolling stock.

JENKINTOWN, PA.—The Huntingdon Valley Street Railway Company has been granted a charter to construct a new trolley line at Rockledge. The incorporators are I. A. Sweigard, president; J. R. Atmore and John S. Gilbert. The capitalization of the company is $30,000.

HARRISBURG, PA.—The following charters were issued at the State Department recently: The Eastern Rapid Transit Street Railway Company, Pittsburg, capital $6,000; the Vandegrift & New Kensington Street Railway Company, Vandegrift, capital $15,000; the Apollo, Vandegrift & Leechburg Street Railway Company, capital $50,000.

PITTSBURG, PA.—C. R. Bucheit, T. N. Barnsdall and E. W. Davis, all of this city, have purchased the electric light and traction plant and two toll bridges between El Paso, Tex., and Juarez, Mex., for $621,000. They will organize in New Jersey the El Paso Electric Company, with a capital of $1,250,000, and will build 50 miles of traction road along the Rio Grande. They have a 50-year franchise with the United States Government and a 10-year contract to supply light in El Paso.

MONTREAL, QUE.—At the annual meeting of the shareholders of the Montreal Electric Street Railway, the statement showed that during the year, the company carried 46,741,000 passengers. The net income per cent of capital was 11.80, the net earnings $795,413 and the operating expenses $1,105,000. The earnings for the year show a net profit of $649,[illegible]1, as compared with $647,246 for the year previous. Out of this amount, four quarterly dividends of 2½ per cent each have been declared, amounting in all to $551,700, leaving a surplus of $97,551, of which amount the sum of $50,000 has been added to the contingent account, and the balance, $47,551, has been added to the surplus account. In addition to the electrically driven plant, the company has purchased and installed two steam units, capable of developing 3,000 horse-power. The company has decided to appropriate $100,000 for a fund, in order to transact the company's own fire insurance, to which fund will be added from $10,000 to $15,000 annually. The following gentlemen were elected directors for the year ensuing: Hon. L. J. Forget, James Ross, K. W. Blackwell, F. C. Henshaw and Hugh Montague Allen. At a subsequent meeting of the directors, Hon. Mr. Forget was re-elected president; Mr. Ross, vice-president, and Mr. F. L. Wanklyn, general manager.

KNOXVILLE, TENN.—It is stated definitely that control of the Knoxville Traction Company has passed into the hands of the Railways & Light Company of America. The Baltimore Trust & Guarantee Company brought about an issue of $850,000 bonds and it was from this company and others that the control was secured.

KNOXVILLE, TENN.—The Knoxville, Kimberlin Heights and Sevierville Electric Railway will be twenty-seven miles from Knoxville to Sevierville, and thence to the headwaters of the east and west forks of Pigeon River, seven and eight miles respectively, and with other branches, will make a total of about fifty-four miles projected and touching three counties. The company has just been chartered with a capital stock of $150,000.

PARIS, TEX.—The Paris Transit Company, which was recently incorporated here, is successor of the Paris Railway Company. It is now building an extension.

SALT LAKE CITY, UTAH.—The Consolidated Railway & Power Company of Salt Lake City, will make extensive improvements in its plant. A large power plant will be built on the banks of the Jordan River, and will cost in the neighborhood of $300,000. It will develop from 2500 to 3000 horse-power.

SALT LAKE CITY, UTAH.—The owners of the Rambler copper mine in the Douglas Creek district, near Grand Encampment, Wyo., will build an electric railway from the Ferris-Haggerty mine, to the Encampment smelter. The new line will be over thirty miles in length and will cost over $200,000.

SALT LAKE CITY, UTAH.—A deal is on foot for the consolidation of electric railway interests to build a $2,000,000 interurban system between the cities of Salt Lake and Ogden has just leaked out. It involves the purchase and consolidation of the Ogden & Salt Lake Railway, including the Hot Springs line and the construction of new roads to fill in the gaps between Brigham City, Ogden Hot Springs and Ogden. The road, it is said, will be under the control of the Everett-Moore syndicate of Cleveland, Ohio.

RICHMOND, VA.—A recent fire totally destroyed the four-story brick structure at the corner of Main and Seventh Streets, occupied by the Richmond Traction Company, the Virginia Electrical Railway & Development Company and the Tower-Binford Electrical Supply Company. Miss Emily Crump, a stenographer, was seriously injured by jumping from a second story window, and a negro porter is believed to have perished in the basement. A number of persons were slightly injured. The total loss is estimated at a little less than $100,000. There was $10,000 insurance on the building, which was owned by Charles T. Davis; the Tower-Binford Company had about $15,000 insurance on stock, and it is understood that the traction and electrical companies had full insurance on their stock and office furniture. The origin of the fire is a mystery. Those who were at work in the building heard a dull report and a moment later dense smoke and flames were seen to rise. It is believed that the boiler of the steam heating plant exploded.

TACOMA, WASH.—The Everett Railway & Electric Company has given a $1,000,000 mortgage to the Manhattan Trust Company, New York, securing bonds for the same amount. The company will extend its system.

KENOSHA, WIS.—Articles of incorporation have been filed by the Wisconsin Inter-Lakes Electric Railway Company. The capital stock of the company is $25,000. The men acting as incorporators are Gerald R. McDowell, Jacob Kroncke and W. T. Marlatt.

NEW INDUSTRIAL COMPANIES.

THE WOOLY SMOKELESS FURNACE COMPANY has been incorporated at Salt Lake City, Utah, with a capital stock of $200,000.

THE ELECTRIC SPECIALTY COMPANY, with Dr. A. W. Gregg, president, has been organized at Kennett Square, Pa. The company has a capital of $25,000.

THE MUNDER ELECTRIC COMPANY has been organized at Saco, Me., for the purpose of manufacturing electrical appliances and supplies, with $50,000 capital stock.

THE COMMERCIAL ELECTRIC TIME COMPANY, of New York City, has been incorporated; capital, $250,000. Directors: Ralph Jonas, Henry Best, and D. M. Edwards, of New York City.

THE AKOUPHONE MANUFACTURING COMPANY, of New York City, has been incorporated; capital, $50,000. Directors: R. C. Maroney, C. W. King and Peter Jenness, New York City.

THE CARBON LIGHT COMPANY has filed articles of incorporation at St. Louis, Mo. The capital stock is $25,000. John P. Barnes, John H. Lucas and William T. Johnson are among the shareholders.

THE CALIFORNIA INCANDESCENT LAMP COMPANY has been incorporated with San Francisco named as the place of business. Directors: F. D. Stringham, A. J. Dibblee, N. A. Dodge, F. Gallinger, and M. F. Michael. Capital stock, $100,000.

THE AMERICAN PUSH BUTTON TELEPHONE COMPANY, of New York City, has been incorporated at Albany; capital, $300,000. Directors: E. G. Potter and F. P. Duryea, of New York City, and R. S. Kristeller, of Brooklyn.

THE DULUTH GENERAL ELECTRIC COMPANY, of Duluth, Minn., has been incorporated; capital stock, $100,000. Incorporators: Alex. W. Hartman, Duluth; R. R. Dunn, St. Paul; Renwick B. Knox, Duluth; Curtis E. Van Bergen, Duluth, and Otto C. Hartman, Duluth.

MONTREAL, QUE.—The Dominion Subway Company is seeking incorporation to construct, maintain, etc., underground conduits, wires, cables and pneumatic tubes in this city. The proposed capital stock is $100,000, and among the names of the incorporators are Charles F. Sise, Robert McKay, Robert Archer, Hugh Paton and Charles Cassils, all of Montreal. The company's headquarters will be in Montreal.

LEGAL.

"PUNY" PUNISHMENT.—An electrical company in Reading, Pa., has asked that a verdict against it of $4,000 punitive damages be set aside on the ground that the word punitive was written "puny" by one of the jurors.

AUTOMOBILE RIGHTS.—A judge in New York when reversing a decision against an automobilist whose machine had caused a horse to run away and wreck the wagon to which it was attached, said: "The horse has no paramount or exclusive right to the road, and the mere fact that a horse takes fright at some vehicle run by new and improved methods and smashes things does not give the injured party a cause of action. Horses may take fright at conveyances that have become obsolete as well as those which are novel; but this is one of the dangers incident to the driving of horses, and the fact cannot be interposed as a barrier to retrogression or progress in the method of locomotion. Bicycles used to frighten horses, but no right of action accrued."

BREACH OF CONTRACT.—The Stromberg-Carlson Telephone Company has brought suit against the Reserve Construction Company, of Cleveland, for $100,000 for breach of contract. The Reserve Construction Company awarded a contract last April to the Stromberg-Carlson Telephone Manufacturing Company for the installation of the general switchboard equipment and the telephone instruments in Detroit for the People's Telephone Company, for the sum of $306,000. Subsequently, after the Stromberg-Carlson Company had made large preparations to fill the contract, the Reserve Construction Company refused to allow the Stromberg-Carlson Company to furnish the apparatus, and the contract was awarded to another concern, the excuse given by the defendant being the desire to avoid alleged threatened patent litigation. The plaintiff claims that any fears of patent litigation were wholly groundless.

LIABILITY FOR OPERATOR'S ACTS.—In Pacific Postal Telegraph Company vs. Bank of Palo Alto, 109 *Federal Reporter* 369, it is held that a telegraph company is responsible in damages for the criminal use of its wires and instruments by a telegraph operator acting in pursuance of a conspiracy with an outside party, and in criminal violation of the duties of his position and employment. It appeared that as a result of a conspiracy between a telegraph operator and a third party to defraud a bank, the plaintiff in the case, a forged telegraphic message purporting to be sent by another bank and ordering the payment of money to a designated person was transmitted to the plaintiff, and that the plaintiff, on the representation of the third party to the conspiracy that he was the person designated in the message, paid him the sum ordered. The Court said: "In holding the telegraph company liable for the wrongful, tortious, and criminal acts of the operator, we are not called upon to make any departure from the established principles of the law. No additional or independent reasoning is required to show that the rule as announced in the telegraph cases is sound and just. Its foundation is based on the principle, often applied by the courts in a great variety of cases, that, if one of two innocent persons must suffer loss by the act of a third, he who put it in the power of the third person to do such act should be compelled to sustain the loss occasioned by its commission."

OBITUARY.

MR. JOHN M. GWINNELL.—The death is announced of Mr. J. M. Gwinnell, president of the Duranoid Manufacturing Company, in the sixty-seventh year of his age.

MRS. JESSE M. SMITH.—A great many of our readers will note with deep regret the sudden death from pneumonia in New York of the wife of Mr. Jesse M. Smith, the well known electrical and mechanical engineer, formerly of Detroit. Mrs. Smith was ill barely three days. Of charming personality she was a frequent companion of her husband in engineering circles and at social functions of a professional character. Mr. Smith has the deep sympathy of a host of friends.

MR. JAMES J. MURRAY.—We regret to record the death of one of the most prominent glass manufacturers of Philadelphia in the person of James J. Murray. He underwent an operation two years ago, from the effects of which he and his friends thought he had fully recovered, but complications set in that resulted in an acute attack, and death followed after a week's illness, Nov. 10. Mr. Murray was proprietor of the Murray Flint Glass Works, at Trenton Avenue, Culvert and Waterloo Streets, one of the most complete glass factories in the country. He grew up in the glass business. Immediately after leaving school he became shipping clerk in 1869 in the old Kent Avenue and Morton Street factory, Brooklyn, then run by Messrs. Leach, Sneider & Pelletier. When this factory passed into other hands, he was selected, although a mere boy, as business manager for the Bushwick Glass Works on Maujer Street, Brooklyn, owned by Messrs. Hoover & Dannenhoffer. In 1878 Mr. Murray went to Philadelphia, and the firm name of Gill & Murray became favorably known to all the glass dealers of the United States, and to those engaged in the electric lighting field. Under the skilled management of Mr. Murray, from renters they soon became owners of the Washington Flint Glass Works at York and Thompson streets. In 1886 Mr. Murray, desiring a larger, more commodious and more up-to-date factory, he left Mr. Gill in charge of the old factory and erected the factory now bearing his name at Trenton Avenue, Culvert and Waterloo streets. Mr. Murray attended strictly to business, and until he felt the effects of ill-health he seldom took a vacation. His great pleasure was to run up to the mountains for a few days, but he usually absented himself for less than a week. He knew only two places—his factory and his home. Four years ago, however, he visited Europe, traveling extensively in France, Switzerland, Italy, Austria, Germany, Holland, Belgium, Great Britain and Ireland. This was one of the bright spots of his life of constant industry. What pleased him most in all he saw was a little spot in the northern part of the County of Antrim, Ireland, the home of his ancestors, where he himself saw the light of day, Aug. 9, 1853, but which he did not remember, having removed to America with his parents in 1856. Mr. Murray was of an amiable disposition, a good conversationalist, and, outside of his business, a most pleasant companion. He was an honest, upright, Christian man. His pew in the Cathedral was filled every Sunday. He leaves behind him a widow and three children. He was buried from the Cathedral, Logan Square, in the presence of a large number of devoted friends. After the solemn requiem high mass, Dr. William Kieran pronounced a beautiful eulogy, and the final blessing was given by the Most Reverend P. J. Ryan, Archbishop of Philadelphia. His remains were placed at the side of his distinguished brother, the author and historian, Dr. John O'Kane Murray, in the New Cathedral cemetery. Mr. Murray has a brother, Rev. Bernard P. Murray, in Chicago, and a sister, also residing in that city.

PERSONAL.

MR. H. L. PATTESON has been appointed purchasing agent for the Crocker-Wheeler Company, of Ampere, N. J.

MR. JOHN MARTIN, president of the John Martin Company, representing the Stanley Electric Manufacturing Company on the Pacific Coast, recently returned to San Francisco after an extended Eastern tour.

MR. ROBERT C. CLOWRY, vice-president of the Western Union Telegraph Company, is visiting the Pacific Coast on one of his regular tours of inspection. He recently arrived in Los Angeles in the special car "Electric" with a party of officials and friends.

MR. H. B. CAMP, of the company bearing his name, and whose vitrified clay conduits are well known in the electrical field for underground work, has been elected president of the Barberton Pottery Company, which will have quite an extensive plant at Barberton, Ohio.

MR. W. B. RANKINE, vice-president of the Niagara Falls Power Company, and other officers have recently returned from a trip to California, where inspection was made of the 184-mile transmission of the Bay Counties Power Company from the North Yuba River to Oakland and San Jose, as described in these pages.

MR. C. J. GLIDDEN.—The resignation of President Chas. J. Glidden as president of the subsidiary companies of the Erie Telephone & Telegraph Company, which was placed in the hands of the directors several months ago, has now been accepted and Mr. Glidden has severed his connection from the management of these corporations. He remains as a director.

DR. WILLIAM DUANE, professor of physics at the Colorado State University, has been granted a patent for an invention by which a large number of telegraphic messages may be sent over one wire, and earth return, at the same time. In the physical laboratory at the university, it is said, he has had as many as eighteen circuits working on the same wire.

MR. D. T. FOLEY, the well known purchasing agent of the Western Telephone Construction Company, Chicago, has recently accepted the position of general superintendent of the factory of the same company, with headquarters at Winthrop Harbor, Ill. His ability and energy admirably fit him for the combined position of general superintendent and purchasing agent, and the Western is fortunate in having a man so well qualified to fill the dual position.

MR. PHILIP JOHN MARKMANN, mechanical engineer of the Louisiana Purchase Exposition Company's Department of Works, who will plan the construction details of the big exhibit buildings, at St. Louis, Mo., has exercised a lasting influence on the building construction of Chicago, in which city he has made his home for a decade or more. The Schiller Building, the Stock Exchange Building and the Montgomery-Ward Building—all skyscrapers of the most approved modern fireproof construction—were built on working diagrams made under his supervision.

MR. JULIAN RALPH, the brilliant newspaper writer and war correspondent, says in the *Mail and Express*, on his return from Europe: "Over all the globe there is no street like Broadway. By day it offers the longest vista of costly mansions of commerce and the greatest unbroken length of busy crowds of which the globe trotter has knowledge. By night it is brilliant beyond comparison with any other city artery that exists. It is so ablaze with light, so brilliant, so fiercely glowing that if you could see it from a balloon five miles in air you might think the street a lantern set in the middle of the island, with thousands parading inside between the lamps."

MR. GONG HEE, of Portland, Ore., is preparing at St. Paul, Minn., what is said to be the first Chinese work on modern electricity. Mr. Hee is in St. Paul with Long Ka Tien, the American head of the Chinese Empire Reform Association. Gong Hee is a practical electrician, graduate of the electrical department of a Portland technical school, and has served as an apprentice and operator with an electric appliance manufacturer. His book, which will be a complete treatise in simple electricity and electrical application, is an extended translation of American text-books, with exhaustive original explanatory addenda, made necessary by the difficulty in translating electrical terms into a language which knows nothing of them. Mr. Gong has completed thirteen lessons, which takes his work up to the subject of electroplating. All of the work, including the multitudinous diagrams and working drawings, has been done with pen and ink. Eight months have been consumed in the work, and Mr. Gong expects to spend a similar period on the book before it is finished.

Trade Notes.

PAN-AMERICAN ENGINE AWARD.—The American Engine Company announces that on Nov. 20 it received the gold medal awarded by the Jury of Awards, Pan-American Exposition, for its American-Ball duplex compound engine.

GRAPHITE PENCILS are being sent out to its friends by the International Acheson Graphite Company, of Niagara Falls, made from graphite produced by Mr. E. G. Acheson's electrical process. The pencils are of excellent quality and write very nicely and smoothly.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is calling attention to the fact that there are two good guarantees back of the goods it is selling; its own, and that of the manufacturers of the various articles. This applies particularly to Gutmann integrating wattmeters, Packard incandescent lamps, Adams-Bagnall arc lamps, and Packard transformers.

THE CENTRAL ELECTRIC COMPANY, Chicago, is distributing to the trade a bulletin on Pittsburg transformers, describing in detail the transformer wiring for three-wire secondary distribution. This bulletin is of interest to all central station managers, and the Central Electric Company will be pleased to send copies to all who have not received them.

DOUBLEDAY-HILL ELECTRIC COMPANY, of Pittsburg, Pa., has lately equipped a large and conveniently located shop for winding and repairing dynamos, motors, arc lamps, and electrical apparatus of all kinds, and has put in charge a foreman of wide experience and great ability. It is now able to turn out such work with great dispatch and with not less satisfaction to the customer.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, of Chicago, has just issued Bulletin No. 6. It is entitled, "How to Construct Telephone Lines," and is an excellent little manual on this important subject. It is not only pithy and direct in style, but is illustrated with cuts that talk also. With the pamphlet goes a little "dodger" which gives a list of big exchanges using Kellogg apparatus.

NEW PUMPS.—The Goulds Manufacturing Company, Seneca Falls, N. Y., has just issued a circular illustrating and describing new styles of pumps. For the most part the circular is devoted to spraying apparatus, one of the outfits being operated by a gasoline engine. The company will soon issue a new catalogue of its triplex electric power pumps. It will gladly send catalogues and circulars to interested persons on application.

S. K. C.—The great transmission companies of California utilize almost exclusively S. K. C. apparatus for the production of the tremendous voltages and transmission of enormous power over such great distances. The system is manufactured by the Stanley Electric Manufacturing Company, of Pittsfield, Mass., and it received at the Pan-American Exposition the highest possible award, a gold medal, for high tension alternating current apparatus.

RICHMONDT ELECTRIC WIRE CONDUIT COMPANY.—The company formerly known as the above has recently changed its name to the American Interior Conduit Company. The personnel of the company has not changed, nor has the product been altered in the slightest. The company still manufactures the Richmondt conduit, but the new name not only indicates a broader field than before, but characterizes the nature of the conduit. During the scarcity of tube caused by the steel strike, the company embraced the opportunity to install additional and improved machinery, thereby greatly increasing the factory output, which was necessary because of the immense demand which the conduit has had. The ready favor with which Richmondt conduit has been received is sufficient evidence of its utility and value.

I. P. FRINK, 551 Pearl Street, New York, who makes a specialty of lighting store interiors, show windows and show cases, reports the following prominent stores as having adopted recently his special patent window reflector, which is so well and favorably known to the trade: Houston & Henderson, Boston, Mass.; Lewis Dry Goods Company, Butte, Mont.; Schuette Bros., Manitowoc, Wis.; Simon Clothing Company, Des Moines, Ia.; the Church-Dodge Company, Troy, N. Y.; L. B. Ogilvie & Company, Paducah, Ky.; Marshall & Ball, Paterson, N. J.; Browning, King & Company, Cincinnati, Ohio, and their new Fourth Avenue store, New York; Adams Dry Goods Company, New York; Simpson, Crawford & Simpson, New York, and the show cases of Jos. H. Bauland Company, and art department of Frederick Loeser & Company, Brooklyn, New York. Mr. Frink is always glad to answer any question on the lighting subject, and his catalogue of the above specialties is a practical help in estimating on this class of work.

DRY KILNS.—Steam hot blast heating and drying apparatus and dry kilns form the subject of a valuable catalogue of 86 pages just brought out by the B. F. Sturtevant Company, Boston, Mass. This company has established a reputation for the scientific excellence of its trade literature, and the latest addition fully maintains the standard. Apart from the trade features, it is a valuable treatise on the general subject of artificial drying of materials, particularly lumber. The apparatus employed in the drying process is very clearly illustrated, and many of the illustrations show typical applications of the system. In the chapter on lumber drying the physical properties of wood are outlined, followed by a full description of the Sturtevant lumber dry kiln, its advantages being clearly pointed out. The general subject is so thoroughly discussed that any one interested in this line of work will have no difficulty in understanding the principles involved and the methods employed to obtain the results.

WHY NOT USE MONTAUK?—This is an obvious inquiry in regard to the following from the *Insurance Press*: "Insulating coverings for electrical wires are generally freely combustible, and even when a building is of practically fireproof construction and switchboard and other apparatus are of standard type, there is still an opportunity for considerable damage by fire following cross currents in bunches of heavily insulated wires. A recent inspection of one of the principal telephone stations in Boston, a risk claimed to be one of the best of its class, showed that the main switchboard, which was inclosed at the back, offered about as much opportunity for the spread of fire as a pile of twigs heaped together for a bonfire. A fire in the sub-station of the Portland Lighting & Power Company at Portland, Me., recently, was due to the ignition of insulation by an arc from a defective switch. The failure of the switch necessitated calling the main station by telephone to shut off the current. Meanwhile the fire had spread to the roof of the building. An insulating material which is sufficiently flexible to be used for covering wires, and which will not ignite at high temperatures, will be welcomed by underwriters, and favored by them in their recommendations to property owners and contractors." The Montauk Fire Detecting Wire Company, of 100 Broadway, New York City, regards its wire as a device exactly adequate to such conditions, either enclosed in the switchboard cables or run parallel with them.

Record of Electrical Patents

UNITED STATES PATENTS, ISSUED NOV. 19, 1901.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, Times Bldg., New York.]

686,704. BUSHING FOR INTERIOR CONDUITS; W. F. Bossert and F. T. Foxenberger, Utica, N. Y. App. filed Aug. 30, 1901. Conducting rails are fixed to the opposite sides of a plank, the trolley makes upper contact and is guided by the plank.

686,729. BRUSH HOLDER FOR DYNAMO ELECTRIC MACHINES; G. Heidel, St. Louis, Mo. App. filed March 18, 1901. Details.

686,739. ELECTRIC RAILWAY; F. Klepetko, Great Falls, Montana, and G. K. Fischer, Salt Lake City, Utah. App. July 19, 1899. The bushing has an ordinary thread at one end to fit into the box, and a coarse thread to receive the spiral conduit at the other end.

686,768. SYSTEM OF ELECTRICAL PROPULSION FOR RAILWAY OR OTHER CARS; G. J. Scott, Philadelphia, Pa. App. filed March 8, 1901. A dynamo is on the same shaft with the motor, the armature of the dynamo being short-circuited and its field magnet in circuit with the motor. The dynamo is inserted between the motor and the axle, and acts as a cushion in starting the car.

686,780. PROPELLING AND STEERING OF BOATS; M. J. Steffens, Chicago, Ill. App. filed July 12, 1901. Two motors driving two propellors are controlled from the shore through a cable.

686,832. ELECTRIC CONDUCTING CABLE; J. D. Peachley, Newark, N. J. App. filed Sept. 21, 1900. A cable composed of a number of insulated wires, each carrying a local mark of identification and a hermetical inclosure for protecting the marks.

686,835. MAGNETIC SEPARATOR FOR ORE OR CONCENTRATES; M. Ruthenburg, Philadelphia, Pa. App. filed May 28, 1900. A separator wherein the magnetizable portion of the material treated, is supported during the process of its extraction by means independent of the magnetic field.

686,836. ELECTRIC FURNACE; Marcus Ruthenburg, Philadelphia, Pa. App. filed Aug. 4, 1900. (See page 895.)

686,856. DYNAMO ELECTRIC MACHINE; W. Langdon-Davies and A. Soames, Surrey, England. App. filed June 14, 1901. An inclosed machine in which the armature is contained in a casing inside of the closed field-casing, ventilating passages being provided through the shaft.

686,859. ELECTRIC GENERATOR AND DISTRIBUTOR FOR MEDICAL TREATMENT; E. L. Madden, Kanawha, Ia. App. filed March 28, 1901. Details.

686,862. ELECTRIC RAILWAY; J. F. Munsie, Brooklyn, N. Y. App. filed Aug. 24, 1899. The switch controlling the branches to the working section is operated by a plunger and a bar carried by the car.

686,886. SEPARATOR FOR STORAGE BATTERIES; Rufus N. Chamberlain, Depew, N. Y. App. filed Sept. 21, 1900. A perforated plate of insulating material provided with raised ribs having a wavy form.

686,889. MAGNETIC SEPARATOR; H. M. Daggett, Philadelphia, Pa. App. filed Aug. 7, 1899. Relates to the relative shape of the pole pieces.

686,892. AUTOMATIC TELEPHONE SYSTEM; Ernest A. Fuller, Baltimore, Md. App. filed Aug. 22, 1901.

686,910. REGULATOR FOR INCANDESCENT LAMPS; F. C. Schofield, Lonaconing, Md. App. filed March 9, 1901. Relates to the disposition of the resistance material in the base of the lamp.

686,918. AUTOMATIC CIRCUIT BREAKER; H. P. Ball, New York, N. Y. App. filed June 25, 1901. Details.

686,919. INDICATING MECHANISM FOR ELEVATORS; A. H. Bates, Cleveland, Ohio. App. filed Jan. 17, 1898. The indicator automatically shows the progress of the car and the direction it should move in case it is stationary.

686,925. PARTY-LINE SELECTOR SYSTEM; Thomas C. Drake, of Malta, Ohio. App. filed March 2, 1901. (See page 895.)

686,941. BONDING PLUG; W. S. Jones, Chicago, Ill. App. filed March 16, 1901. An electrical bonding plug, tapered approximately uniformly and provided with a longitudinal groove of approximately uniform depth and of varying width.

686,942. ELECTRIC SERVOMOTOR; P. M. La Hegarat, Paris, France. App. filed March 12, 1901. Apparatus for controlling a motor from a distance.

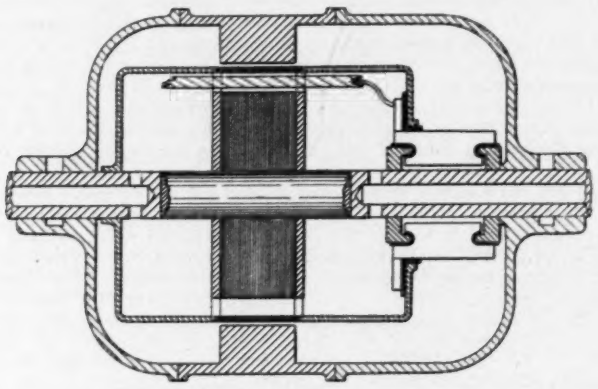
686,973. RAILWAY CROSSING SIGNAL; B. A. Karr, Council Bluffs, Ia. App. filed July 18, 1901. Details.

686,974. RAILWAY SIGNALING DEVICE; L. C. Karr, Council Bluffs, Ia. App. filed July 20, 1901. A track circuit closer operated by the flange of the wheel and embodying a dash-pot to hold the circuit closed a sufficient length of time.

687,042. ANTI-HUNTING DEVICE; A. D. Lunt, Schenectady, N. Y. App. filed June 25, 1900. (See Current News and Notes.)

687,044. RHEOSTAT; F. Mackintosh, Schenectady, N. Y. App. filed April 22, 1901. A rheostat having a length of resistance wire bent back and forth upon itself, and mounted between insulated heat-conducting plates, a number of bends of the wire being permitted to project from the edges of the plates, and contact-studs connected with said bends.

687,048. TRANSFORMER; W. S. Moody, Schenectady, N. Y. App. filed May 31, 1901. In a transformer, the combination with the core, of two



686,856.—Dynamo Electric Machine.

superposed windings thereon which occupy less than the total winding space, and a separate auxiliary regulating winding located in the remaining winding space and connected with the inner winding, but not surrounded by the outer winding.

687,050. INDICATING INSTRUMENT; T. F. Mullaney, New York, N. Y. App. filed Aug. 16, 1901. In a synchronizing device, two voltmeters arranged so that the needles of both move in proximity to each other, and means for relatively adjusting the position of one voltmeter-needle with respect to the other.

687,053. MAGNETIC SEPARATOR; R. McKnight, Philadelphia, Pa. App. filed Feb. 4, 1901. In order that the attractive force of the magnets may not entail more work upon the power devices in moving the conveyor belt, the magnets are caused to travel with the belt.

687,060. SYSTEM OF MOTOR CONTROL; C. L. Perry, Schenectady, N. Y. App. filed June 21, 1900. In a system for controlling the operation of a plurality of switches, a plurality of actuating windings for said switches, and means for supplying current to a determined number of said windings in series, or to a lesser number in series with a current-limiting resistance.

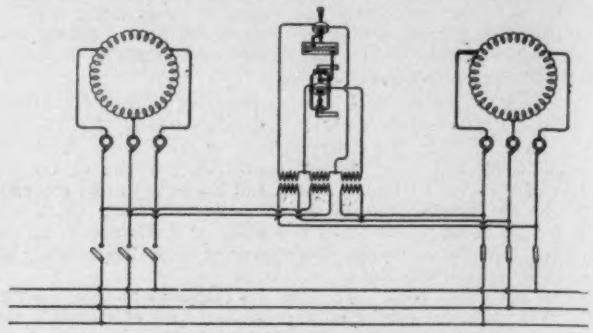
687,065. CIRCUIT BREAKER; R. H. Read, Schenectady, N. Y. App. filed July 18, 1901. A circuit breaker provided with main and shunt contacts, a path of low impedance for the shunt-contact when the main contacts are separated, and a blow-out coil cut into circuit before final rupture.

687,078. ALTERNATING CURRENT SYSTEM; C. P. Steinmetz, Schenectady, N. Y. App. filed May 26, 1900. (See Current News and Notes.)

687,087. SWITCH SIGNAL; B. H. Urschel and E. P. Thomas, Sugarridge, Ohio. App. filed May 26, 1900. Apparatus operated by a moving car in such a manner as to leave a signal light at one switch and at the same time turn on a light at the next switch ahead, and upon passing the latter, to turn out both lamps.

687,091. RAIL BOND; C. Walther, Berlin, Germany. App. filed June 27, 1900. A multiple contact device between the end of the bond and the rail.

687,098. ELECTRIC RAILWAY; G. T. Woods, New York, N. Y. App. filed



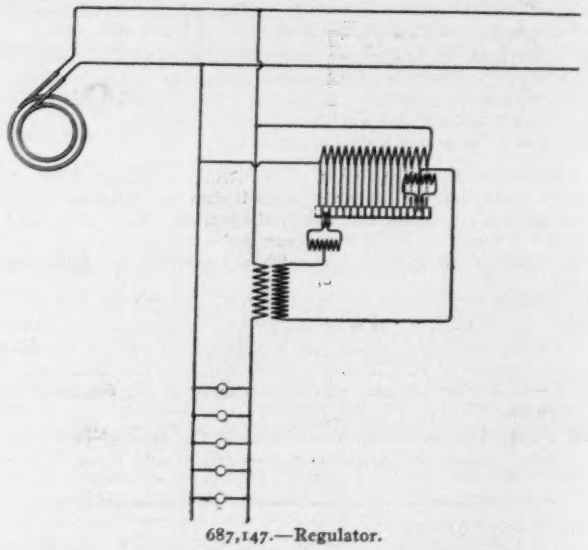
687,050.—Indicating Instrument.

June 29, 1900. Mechanical means are provided for automatically forcing the section switch to open when no current in excess of a pre-determined minimum, is flowing through its coil.

687,121. ELECTRIC BATTERY; E. F. Callender, Galesburg, Ill. App. filed April 17, 1901. A hollow carbon element having a lining of insulating material, the zinc pencil passing therethrough.

687,124. SYSTEM OF ELECTRIC CIRCUITS; F. E. Case, Schenectady, N. Y. App. filed June 29, 1901. In an electric railway system, the combination with one or more electric motors, of a plurality of separately-actuated contacts for varying the motor speed, separate coils connected in multiple and responsive to different current strengths for effecting the actuations of said contacts, means for sending a current of varying strength through said coils, and means for cutting out preceding coils as each coil becomes energized.

687,140. SYSTEM OF ELECTRICAL DISTRIBUTION; A. R. Everest, Lynn, Mass. App. filed May 31, 1901. (See Current News and Notes.)



687,147.—Regulator.

687,141. CURRENT TRANSFORMER; A. R. Everest, Lynn, Mass. App. filed July 29, 1901. A current transformer comprising a primary having a symmetrical cross-section, a core of magnetic material conforming in shape with the cross-section of the primary, and a secondary suitably disposed in inductive relation with the primary.

687,143. SYSTEM OF MOTOR CONTROL; P. Farnsworth, Schenectady, N. Y. App. filed April 22, 1901. Means whereby any desired portion of the motors connected with the load through a clutch can have its counter-electromotive force varied by the inertia of the load to vary the potential around another portion of the motors rigidly connected with the load.

687,147. REGULATOR; R. Fleming, Lynn, Mass. App. filed July 20, 1900. The electromotive force impressed upon the primary winding of a regulating transformer, is made variable, as well as reversible, by shifting the primary terminals of the regulating transformer across a series of contacts connected at suitably graduated intervals to a compensator-winding supplied from the main circuit.

11,945. RAILWAY BRAKE; A. Green, Rochester, N. Y. App. filed March 26, 1901. The electric brake is applied at the same time as a mechanical brake, but at such a time in the movement as to obtain the highest efficiency of the electrical apparatus.